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COVER IMAGE

Fruiting branchlets and inflorescences of the flowing plant genus *Gaultheria* (Ericaceae) from the Gaoligong Shan, a mountainous region along China's border with Myanmar. For details, see Fritsch et al., this issue, pp. 147–213.

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The Harvestman Family Phalangodidae. 6. Revision of the *Sitalcina* Complex (Opiliones: Laniatores)

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The *Sitalcina* complex, currently encompassing species placed in *Sitalcina* Banks and *Microcina* Briggs and Ubick, is revised and shown to be much more diverse than previously envisioned. Both *Sitalcina* and *Microcina* are now restricted to include only those species most closely related to their types, *Sitalcina californica* (Banks) and *Microcina tiburona* (Briggs and Hom), respectively. For the remaining species currently in *Sitalcina*, three new genera are proposed: *Enigmina* (for *S. granita* Briggs), *Megacina* (for *S. cockerelli* Goodnight and Goodnight and *S. madera* Briggs), and *Tularina* (for *S. scopula* Briggs). A fourth new genus, *Microcinella*, is proposed for *Microcina homi* Briggs and Ubick. The following species are newly described: *Enigmina warrenorum*, *Megacina mayacma*, *Megacina schusteri*, *Microcina potrero*, *Microcina sanbruno*, *Microcina stanford*, *Microcina tamalpais*, *Microcinella coensis*, *Sitalcina catalina*, *S. peacheyi*, *S. rothi*, *S. seca*, *Tularina plumosa*, and *T. tularensis*. The subspecies, *S. flava chalonga* Briggs, is elevated to species status.

We examined over three dozen characters, of which 29 were found to be informative and analyzed in a parsimony analysis (PAUP*). The *Sitalcina* complex is not supported by any apparent synapomorphies. Its most divergent member, *Microcinella*, has the most plesiomorphic genitalia, which suggests it is basalmost in the folding-glans clade. The relationships among the remaining genera are not fully resolved. The clades, (*Microcina* (*Sitalcina* + *Enigmina*)) and (*Megacina* + bifurcate clade), seem well supported as they were recovered in virtually all searches. The placement of *Tularina* is less clear, but its relationship with *Megacina* is suggested by some genital characters.

Biogeographically, the *Sitalcina* complex is primarily Californian, with extensions into Oregon and Arizona. A vicariance model suggests some probable barriers, although considerable dispersal is necessary to account for the several cases of sympatry.

Ecologically, the species represent two body types, which correlate with habitat: 1) large, eyed species found in forests (*Sitalcina*, *Megacina*, *Enigmina*); and 2) small, blind species from grasslands (*Microcinella*, *Microcina*, *Tularina*). Interestingly, although the habitus of grassland species is most likely derived (paedomorphy), the three genera are phylogenetically relatively basal.

KEYWORDS: Opiliones, Laniatores, Phalangodidae, *Sitalcina*, California, taxonomy, biogeography

The Nearctic harvestmen of the family Phalangodidae are remarkable in many ways. These small laniatorids (Fig. 1), easily recognized by their yellowish to orange coloration (Figs. 2–3) and slow movements, occur in cryptozoic habitats and were previously only rarely collected. Recent

studies are showing that these organisms are both abundant and diverse. In fact, the family turns out to be amazingly speciose, being by far the largest opilionid family in the Nearctic. With this study, the number of phalangodids is increased to 108, representing some 40% of all Nearctic opilionid species. Evolutionarily, the hotspot of diversity is the Californian region, which now includes 66 species, some 60% of Nearctic phalangodids.

Phalangodids are also morphologically very diverse, showing much variation in both somatic and genitalic characters. Somatically, the species differ in the degree and arrangement of cuticular ornamentation and the form of the secondary sexual structures. Many species show adaptations to cave and interstitial life through varying degrees of depigmentation, appendage elongation, and eye reduction.

However, it is the genitalic characters that are most variable, especially the bewildering array of structures on the male penis.

Our studies of the male genital characters suggest a division of the family into three groups. The first, represented by *Calicina* Ubick and Briggs, has a glans that telescopes out of the truncus during expansion (Fig. 4c–e). As this mode of expansion is interpreted as plesiomorphic in the family (Ubick and Briggs, 1989), the genus is placed as sister to all remaining Nearctic phalangodids, those with a folded glans that unfolds during expansion (Figs. 8a–e). This “folding glans clade” further divides into two groups. Of these, the “bifurcate clade” includes those species with a deeply divided ventral plate (Figs. 5d–e), currently placed in *Banksula* Roewer, *Texella* Goodnight and Goodnight, and *Phalangodes* Tellkamp et al. (Ubick 2007). (This latter group, henceforth referred to in this study as *Phalangodes* et al., also includes the following closely related genera of the eastern Nearctic: *Bishopella* Roewer, *Crosbyella* Roewer, *Tolus* Goodnight & Goodnight, *Undulus* Goodnight & Goodnight, and *Wespus* Goodnight & Goodnight). All of the remaining species, those with entire (unmodified) ventral plates and presently contained in *Sitalcina* and *Microcina*, are referred to as the “*Sitalcina* complex”. In this study we revise this complex and, in so doing, also complete our preliminary survey of the Californian phalangodid fauna.

The genus *Sitalcina* was defined by Banks (1911) to include only his previously described species, *Sitalces californica* Banks (1893) (Fig. 1). Two additional species, *S. cockerelli* and *S. lobata*, were later added to the genus by Goodnight and Goodnight (1942). Our knowledge of the genus was greatly expanded in the 1960s, when intense collecting and study increased the

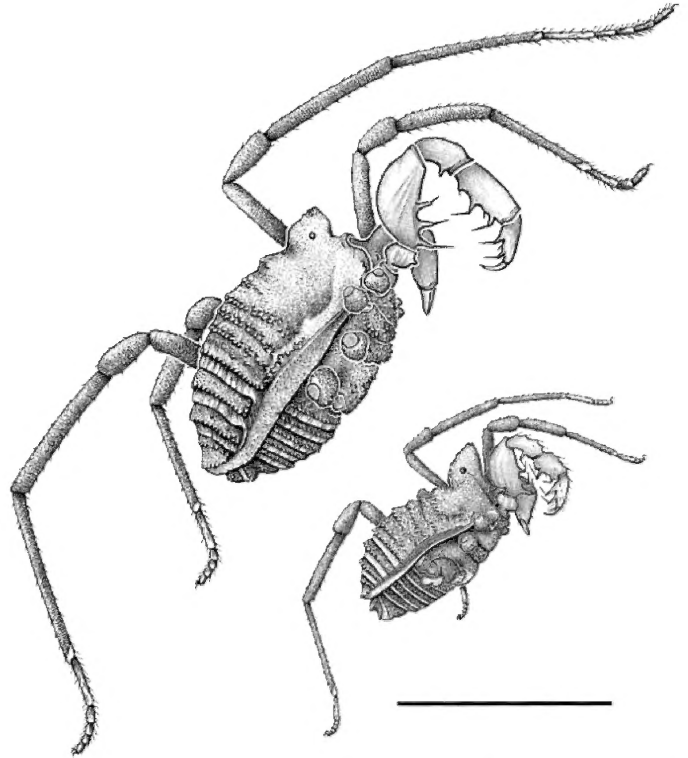


FIGURE 1. *Megacina cockerelli* (Goodnight and Goodnight), upper left, and *Sitalcina californica* (Banks), lower right, the two commonest sitalcinoid species, males in lateral view. Scale bar = 2mm. (Illustrated by J. Speckels)

species number ten fold (Briggs and Hom 1966, 1967; Briggs 1968). Since that time, additional collecting has produced a steady stream of new species, which still continues to flow. With the help of improved imaging, especially through scanning electron microscopy, a more detailed study of the morphology became possible and revealed a number of surprises, especially the unexpectedly high variation in male genitalic structures. The genus *Sitalcina* turned out to include species with two radically different forms of the male genitalia. In the first, the glans telescopes out of the truncus during expansion, in the second it unfolds. As the type species, *S. californica*, has a folding glans, those species with a telescoping glans were moved to a new genus, *Calicina* (Ubick and Briggs, 1989). However, the remaining species in *Sitalcina* were also somatically diverse. Whereas most species have the dorsal cuticle composed of discrete tubercles (Figs. 15a-c), in some the tubercles are connected by ridges giving a honeycombed, or areolate, sculpturing (Figs. 7a-b). On the basis of this apparent synapomorphy, these latter species were moved to another new genus, *Microcina* (Briggs and Ubick, 1989).

As the *Sitalcina* complex was not defined by synapomorphies, one important challenge for the study was to find one. However, our search for characters failed to turn up even a single shared derived character for the complex. Furthermore, our character analysis indicates that not even *Microcina* and *Sitalcina* as currently maintained are monophyletic. In fact, newly discovered synapomorphies from both somatic and genitalic characters now suggest the presence of four additional genera.

The first is *Microcinella*, whose single described species, *M. homi*, was previously included in *Microcina* (Briggs and Ubick, 1989). In that study, we defined *Microcina* on the basis of a single synapomorphy, the areolate cuticular ornamentation. However, examination of a wider sample of sitalcinoids now indicates that areolate cuticle is much more widespread than previously noted (Figs. 38, 45, 47, 49), being found in additional species which, on both genitalic and other somatic features, are clearly unrelated to *Microcina*. Although areolate cuticle may turn out to be phylogenetically relevant at higher levels, it no longer supports the monophyly of *Microcina*. Thus, the differences observed between the two included species groups become more significant. In the *tiburona* group (= *Microcina* in the present interpretation), the male genitalia have a dorsal lobe (Figs. 8, 10a-c), the female ovipositor trifurcate apical setae (Figs. 11g), and the male a unique sexual dimorphism, an enlarged eyemound (Figs. 9a-d), all of which are absent in the *homi* group (= *Microcinella*) (Figs. 6-7). However, it is the male genitalia of *Microcinella homi* that are fundamentally different, not just from *Microcina*, but from all remaining phalangodids. Here, the glans both unfolds and telescopes during expansion (Figs. 6a-b), a condition that to our knowledge is unique in the family and whose interesting evolutionary ramifications are discussed in the Phylogeny section. The validity of *Microcinella* is further supported by the discovery of a second species, here described as *M. coensis*.

The genus *Sitalcina* as presently maintained is even more polymorphic than *Microcina*, with species differing in numerous genitalic and somatic characters. It is here restricted to include only those species closely related to the type species, *Sitalcina californica*. These species share synapomorphies in the male genitalia (glans with large flap-like dorsal lobe, Figs. 13-14a-f), female genitalia (ovipositor with microspines in imbricate arrangement, Fig. 16i), and the form of the secondary sexual structures (male with TrIV spur, Figs. 15g-h). Excluded from *Sitalcina* are four currently described species (along with five new ones) that lack these synapomorphies and are here assigned to three new genera.

The first of these is represented by *Sitalcina scopula*, the only remaining blind member of *Sitalcina*, as the others were previously transferred to *Calicina*, *Microcina*, and (now) *Microcinella*. This species lacks a TrIV spur (although it does have a ventral tubercle, Fig. 42f), has fused PSL

on the glans (Figs. 37j–k, 43a–d), and lacks ovipositor microspines (Figs. 43e–g). This species, along with two new ones (*T. tularensis* and *T. plumosa*), is here assigned to the new genus, *Tularina*.

Two additional species, *Sitalcina cockerelli* and *S. madera*, differ from *Sitalcina*, and all other known phalangodids, in having a glans that folds asymmetrically, with the dorsal and ventral surfaces occupying lateral positions in the folded glans (Figs. 44c–d, 46a–c, 53a–e). This unique and unusually complex mechanism is clearly a strong synapomorphy for the new genus, *Megacina*, which also includes two new species, *M. schusteri* and *M. mayacma*. These species also differ from *Sitalcina* in other characters. The female has a glabrous ovipositor, lacking microspines (Figs. 46g–i, 48f–i, 50g–i, 54a–c) and the male TrIV lacks a spur, but may have tubercles (Figs. 52f–g, i). In three species (the *madera* group) leg IV has an unusual modification: a somewhat swollen Tr and a Fm with a basoventral process (Figs. 45e–f, 47e–g, 49d–e).

Finally, *Sitalcina granita* does not share any convincing synapomorphies with the above genera. It resembles *Megacina* and (most) *Tularina* in lacking ovipositor microspines (Figs. 34h, 36j), but *Sitalcina* in having a glans with full complement of lobes (Figs. 14g–h, 34a–d, 36a–f) and TrIV with short processes resembling spurs (Figs. 33e–f, 35e–g). The species is unique in the complex in having a short, stout stylus (Figs. 14g–h, 34a–c, 36a–d) and is here placed in a new genus, *Enigma*, which also includes the new species, *E. warrenorum*.

METHODS

The format of this study follows that of Ubick and Briggs (1989). Standard observations and measurements were through a dissecting microscope (Leica MZA 12.5), using magnifications up to 100x. Closer examination was with a compound microscope (Nikon YS2-H) and some specimens were also imaged with auto montage (using Syncroscopy software). Where possible, few to several specimens per species were also examined through scanning electron microscopy (Hitachi S-520), indicated as “(SEM)” in the species accounts. As the distributions of the taxa are presented all in one place (Figs. 56 and 57), this reference is not repeated in the Taxonomy section. All measurements, unless otherwise stated, are in mm.

Abbreviations: 1. Somatic morphology: AT = anterior tubercles of scute, GO = genital operculum, EM = eyemound, Fm = femur, FmIV = femur of leg IV, LII/SL = leg II/ scute length, TC = tarsal count, TrIV = trochanter of leg IV. 2. Penis morphology: DL = dorsal lobe of glans, PSL = parastylar lobe(s) of glans, S = stylus, SB = stylar base, VP = ventral plate of penis, VS = ventral setae of ventral plate, AS = apical spine of ventral plate. (Note that the ventral and dorsal aspects of the glans refer to that of a fully expanded penis. These positions thus appear reversed in a folded glans; i. e., the ventral surface assumes a dorsal position.) 3. Ovipositor morphology: OV = ovipositor, OVM = ovipositor microspines, OVS = ovipositor apical setae.

The majority of the 1800 specimens examined are deposited at the California Academy of Sciences (CAS). Other material is from the American Museum of Natural History (AMNH), Museum of Comparative Zoology (MCZ), and Universities of California at Berkeley (UCB), Davis (UCD), and Riverside (UCR), along with the personal collections of James Cokendolpher (CJC), William Shear (CWS), and D. Ubick (CDU).

TAXONOMY

Phalangodidae Simon, 1879

Key to the Genera of Nearctic Phalangodidae

Males

1. Penis with VP bifurcate (Figs. 5d–e) 2
 Penis with VP entire (Fig. 4d) 4
2. VP prongs in ventral position (Fig. 5e); palpal Fm with dorsal tubercles (Fig. 5b) *Banksula* Roewer
 VP prongs in lateral position (figs. 4.35f–g: Ubick 2007); palpal Fm lacking dorsal tubercles 3
3. VP prongs thin; glans large (fig. 4.35f: Ubick, 2007) *Texella* Goodnight and Goodnight
 VP prongs swollen; glans small (fig. 4.35g: Ubick, 2007) *Phalangodes* Tellkamp, et al.
4. Glans expands only by telescoping out of truncus (Figs. 4c–e) ... *Calicina* Ubick and Briggs
 Glans unfolds from truncus. 5
5. S telescopes out of glans; DL absent (Fig. 6) *Microcinella*, gen. nov.
 S does not telescope out of glans; DL usually present 6
6. Glans folding complex, asymmetrical (Fig. 44) *Megacina*, gen. nov.
 Glans folding simple, symmetrical 7
7. Eyes present (Fig. 15a) 8
 Eyes absent (Figs. 9a–d) 9
8. TrIV with ventral process (spur) longer than 1/2 Tr width (Figs. 15g–h) *Sitalcina* Banks
 TrIV with ventral process shorter than 1/3 Tr width (Fig. 35e) *Enigmina*, gen. nov.
9. Glans with DL broad; PSL separate (Fig. 8) *Microcina* Briggs and Ubick
 Glans with DL absent or, when present, pointed; PSL fused (Fig. 37) ... *Tularina*, gen. nov.

Females (excluding *Phalangodes* et al.)

1. OV with one pair of apical teeth (Fig. 5i) 2
 OV lacking apical teeth (Fig. 4f) 3
2. OVM absent (Fig. 5j); palpal Fm with dorsal tubercles (Fig. 5b) . . *Banksula* Roewer (in part)
 OVM present (figs. 18–21: Ubick and Briggs, 1992); palpal Fm lacking dorsal tubercles *Texella* Goodnight and Goodnight
3. Eyes present (Fig. 15a) 4
 Eyes absent (Figs. 9a–d) 8
4. OVM present (Fig. 4g) 5
 OVM absent (Fig. 36j) 6
5. OVM in random arrangement (Fig. 4g) *Calicina* Ubick and Briggs (in part)
 OVM in imbricate arrangement (Fig. 16f) *Sitalcina* Banks (in part)
6. Palpal Fm with row of dorsal tubercles (Fig. 17a) *Sitalcina* Banks (in part)
 Palpal Fm lacking row of dorsal tubercles 7

7. EM at anterior scute margin (Figs. 35a–b) *Enigmina*, gen. nov.
EM posteriad of anterior scute margin (Figs. 45b–c, 47a, 49a–b, 51) *Megacina*, gen. nov.
8. OVM in transverse rows (Figs. 39j, 41i), or absent (Fig. 43g) *Tularina*, gen. nov.
OVM in random arrangement (Fig. 4g) 9
9. Scute cuticle tuberculate (Fig. 4b) 10
Scute cuticle areolate (Figs. 7a–b) 11
10. Palpal Fm with dorsal tubercles (Fig. 5b) *Banksula* Roewer (in part)
Palpal Fm lacking dorsal tubercles (Fig. 4a) *Calicina* Ubick and Briggs (in part)
11. OVS with pointed tips (Figs. 7c–d) *Microcinella*, gen. nov.
OVS with trifurcate tips (Fig. 11g) *Microcina* Briggs and Ubick

Genus *Microcinella* Ubick and Briggs, gen. nov.

TYPE SPECIES: *Microcina homi* Briggs and Ubick, 1989.

DIAGNOSIS.—*Microcinella* differs from all known phalangodids in having a penis where the glans both unfolds and telescopes during expansion (Figs. 6a–b). Females are unique in having an ovipositor with randomly distributed microspines and apical setae hooked and with pointed tips (Figs. 7c–d). A possible synapomorphy for the genus is the form of parastylar lobes, which are rounded and with a papillate surface (Fig. 7g–h).

ETYMOLOGY.—The genus name is a diminutive of *Microcina* and is considered feminine in gender.

DESCRIPTION.—Body length 0.85–0.97. Dorsum with areolate sculpturing, scute with 1 pair of small AT, additional tubercles lacking except for few along posterior tergal margins. EM broad and low, lacking eyes. Cheliceral base with abrupt dorsodistal swelling, somewhat larger in female. Palpal trochanter with tuberculate dorsal swelling. Palpal megaspines: femur 3 ventrobasal, 1 mesodistal; patella 1 mesal; tibia and tarsus each 2 ectal, 2 mesal. TC, 3-4-4-4

Male: Penis with VP entire, bearing 5 pairs of short and 1 pair of long setae; glans unfolds during expansion, with one pair of rounded papillate PSL, without DL, S sinuous and attenuate, with subapical tubule, telescopes out of glans at base of PSL.

Female: Ovipositor cuticle with randomly distributed microspines, with 7 pairs apical setae, hooked and with pointed tips.

Sexual dimorphism: None observed.

INCLUDED SPECIES.—*M. homi* (Briggs and Ubick), *M. coensis* sp. nov.

DISTRIBUTION.—Known only from the south of San Francisco Bay, California: Santa Clara, Stanislaus, and Monterey counties.

Microcinella homi (Briggs and Ubick, 1989), comb. nov

Figs. 2a, 3a, 6a–b, 7.

Sitalcina minor [part] Briggs and Hom, 1966:263.

Microcina homi Briggs and Ubick, 1989:210. Kury, 2003:219.

DIAGNOSIS.—See *M. coensis*.

NEW RECORD.—CALIFORNIA: **Santa Clara Co.:** San Jose: Communication Hill, SW of County Fair-ground, under serpentine rock in grassland, 24 February 1993 (R. White, CAS), 1 male, 1 female.

DISTRIBUTION.—Known only from Santa Clara County, California.

Microcinella coensis Ubick and Briggs, sp. nov.

Figs. 6d–f.

TYPE MATERIAL.—Male holotype from under basalt rock in oak chaparral at 8.9 mi N of Bell Station, Henry Coe State Park, Santa Clara County, California, collected on 31 March 1989 by T. Briggs, K. Hom, W. Rauscher, and D. Ubick, deposited at CAS.

ETYMOLOGY.—The species name refers to the type locality.

DIAGNOSIS.—The male of this species differs from that of *M. homi* in having a more strongly curved stylus with a more complex tip.

DESCRIPTION.—Body length 0.89–0.97, LII/SL 2.48–2.76 (N = 2). Color pale orange yellow, abdomen lighter with many white globules visible through integument, appendages yellowish. Body with tubercles arranged in areolate pattern, except at eye mound and venter, posterior tergal margins with tubercles; scute with one pair of AT. EM low, lacking retina and cornea. Palpal megaspines: trochanter 0; femur 3 ventrobasal, 1 mesodistal; patella 1 mesal, 0 ectal; tibia and tarsus 2 mesal, 2 ectal. TC, 3-4-4-4.

Male, holotype (paratype): Body length 0.97 (0.89). Scute length 0.65 (0.64), width 0.64 (0.61). EM length 0.14 (0.14), width 0.15 (0.15), height 0.08 (0.08). Genital operculum length 0.12 (0.13), width 0.15 (0.15). Leg II length 1.62 (1.78), LII/SL 2.48 (2.76). TrIV lacking spur or tubercles. GO rounded hexagonal. Penis VP apically rounded, with 1 pair of long and 5 pairs of short setae, AS absent; glans both folds and telescopes, with 1 pair of rounded papillate PSL; S sinuous, with apical tube long, curved ventrally to form loop.

Female, unknown.

Juvenile (probably this species): Color of body yellowish white, appendages white. Body smooth, lacking tubercles, dorsally with uniform areolate network. Abdomen without apparent segments, but with transverse rows of long setae. Body length 1.00. Scute length not discerned, width 0.55. EM length 0.10, width 0.14. Palpal megaspines as in adult. TC not clearly visible, appears as 2-2-2-2.

NATURAL HISTORY.—Specimens have been collected from beneath serpentine and basalt rocks in oak and oak-pine chaparral.

MATERIAL EXAMINED.—CALIFORNIA: **Santa Clara Co.:** Henry Coe State Park, 8.9 mi N of Bell Station, under basalt rock in oak chaparral, 31 March 1989 (T. Briggs, K. Hom, W. Rauscher, D. Ubick, CAS), male holotype; Henry Coe State Park, halfway between Manzanita Point Group Camp and Madrone Soda Spring, under rock, 11 March 1989 (T. Briggs, K. Hom, A. Jung, D. Ubick, CAS), 1 juvenile, probably this species. **Stanislaus Co.:** Henry Coe State Park, 15.0 mi N of Bell Station, under serpentine rock in digger pine-oak chaparral, 31 March 1989 (T. Briggs, K. Hom, W. Rauscher, D. Ubick, CAS), 1 male paratype.

DISTRIBUTION.—Known only from Henry Coe State Park, Santa Clara and Stanislaus counties, California.

Microcinella species

NOTE.—A female collected in Monterey County is clearly a *Microcinella*, given its small size, areolate cuticular ornamentation, and an ovipositor with hooked, pointed apical setae. Because of the disjunction from other *Microcinella*, the specimen most probably represents a new species. Although a description of the species is not possible until the discovery and study of male specimens, this record is mentioned here to document the dramatic range extension of the genus.

MATERIAL EXAMINED.—CALIFORNIA: **Monterey Co.:** SE corner of Ft. Ord, oak forest, under sandstone, 5 January 1997 (T. Briggs, D. Ubick, CAS), 1 female.

***Microcina* Briggs and Ubick, 1989**TYPE SPECIES: *Sitalcina tiburona* Briggs and Hom, 1966*Microcina* Briggs and Ubick, 1989:208. Kury, 2003:219.

DIAGNOSIS.—These small and blind harvestmen are somatically similar to those in *Microcinella* and *Tularina*, but the genus differs from all sitalcinoid genera by the form of the male genitalia (glans with a small dorsal lobe and a pair of small triangular parastylar lobes, Fig. 8), female genitalia (ovipositor setae with trifurcate tips, Fig. 11g), and a unique sexual dimorphism (the male with an enlarged eyemound, Figs. 9a–d).

DESCRIPTION.—Body length 0.82–1.20. Dorsum with areolate sculpturing, scute with 1 pair of small AT, usually lacking additional larger tubercles. EM broad and low, enlarged in male, lacking eyes. Cheliceral base with abrupt dorsodistal swelling somewhat larger in female. Palpal trochanter with tuberculate dorsal swelling. Palpal megaspines: femur 3 ventrobasal, 1 mesodistal; patella 1 mesal; tibia and tarsus each 2 ectal, 2 mesal. TC, 3-4-4-4

Male: Penis with VP entire, bearing 3–4 pairs of short and 1 pair of longer setae; glans only unfolds during expansion, with small DL, PSL separate, triangular in shape, surfaced with oblique rows of fringes; S sinuous, lacking subapical tubule.

Female: Ovipositor cuticle with randomly distributed microspines, with 7 pairs of apical setae, strongly sinuous and with trifurcate tips.

Sexual dimorphism: Male eyemound enlarged.

INCLUDED SPECIES.—This genus includes those species previously placed in the *tiburona* group of *Microcina* (Briggs and Ubick, 1989) and the new species described here: *M. potrero*, *M. sanbruno*, *M. stanford*, and *M. tamalpais*.

DISTRIBUTION.—Known from the San Francisco Bay Region, from Marin County south to Santa Clara County, California.

***Microcina tiburona* (Briggs and Hom, 1966)**

Figures 2b, 3b.

Sitalcina tiburona Briggs and Hom, 1966:265. Briggs, 1968:27.*Microcina tiburona*, Briggs and Ubick, 1989:212. Kury, 2003:219.

DIAGNOSIS.—This species is slightly larger than other *Microcina*, from which the male differs by the combination of stylus moderately curved and parastylar lobes rounded and with a coarse fringe.

NEW RECORD.—CALIFORNIA: **Marin Co.:** South Tiburon Ridge: Marinero Estates, W122°27'6", N37°53'5", under serpentine rock in oak chaparral, 18 April 1993 (D. Ubick, CDU), 3 males, 2 females.

DISTRIBUTION.—Known only from the Tiburon Peninsula.

***Microcina tamalpais* Ubick and Briggs, sp. nov.**

Figures 8a–e, 12.

TYPE MATERIAL.—Male holotype from beneath basalt rock in grassland-woodland ecotone, Bald Hill, between Worn Springs Fire Rd. and W Upper Rd., Ross, Marin County, California, collected on 17 February 1991, by T. Briggs, P. and L. Hoch, deposited at CAS.

ETYMOLOGY.—The species name is a noun in apposition taken from the type locality on Mount Tamalpais.

DIAGNOSIS.—Males of this species differ from other *Microcina* in having short triangular parastylar lobes, similar to but shorter than those in *M. edgewoodensis*.

DESCRIPTION.— Body length 0.90–0.95, LII/SL 2.57–2.74 ($N = 3$). Color light orange, abdomen yellowish with white masses (gut diverticula) visible through integument; appendages yellowish. Body with areolate sculpturing throughout, lacking tubercles on scute and tergal margins; scute with 1 pair of AT. EM low and rounded, eyes absent, lacking retina and cornea. Palpal megaspines: trochanter 0; femur 3 ventrobasal, 1 mesodistal; patella 1 mesal (with apical seta), 0 ectal; tibia and tarsus each with 2 mesal, 2 ectal. TC, 3-4-4-4.

Male, holotype (2 paratypes): Body length 0.95 (0.90–0.92). Scute length 0.62 (0.62–0.65), width 0.57 (0.57–0.59). EM length 0.14 (0.15), width 0.16 (0.14–0.16), height 0.10 (0.10). GO length 0.13 (0.11–0.12), width 0.14 (0.13–0.15). Leg II length 1.70 (1.63–1.67), LII/SL 2.74 (2.57–2.63). TrIV spur absent. GO rounded, pentagonal. Penis VP entire, with 1 pair long and 4 pairs short lateral setae, AS absent; glans with short DL, with PSL short and triangular; S sinuous, projecting more than half its length beyond PSL.

Female, unknown.

NATURAL HISTORY.— Specimens have been collected under basalt rock in a grassland-woodland ecotone.

MATERIAL EXAMINED.— CALIFORNIA: **Marin Co.**: Ross, Bald Hill, between Worn Springs Fire Rd. and W Upper Rd., grassland-woodland ecotone, under basalt rock, 17 February 1991 (T. Briggs, P. and L. Hoch, CAS), male holotype, 2 male paratypes (SEM).

DISTRIBUTION.— Known only from the type locality.

***Microcina potrero* Ubick and Briggs, sp. nov.**

Figures 8f–i.

TYPE MATERIAL.— Male holotype from beneath serpentine rocks in *Eucalyptus* grassland, on Potrero Hill (Lot E of Potrero Avenue between 20th and 21st streets and Highway 101), San Francisco, California, collected on 26 December 1990, by T. S. Briggs, deposited at CAS.

ETYMOLOGY.— The species name is a noun in apposition taken from the type locality.

DIAGNOSIS.— Males of this species differ from other *Microcina* in having long parastylar lobes, resembling those in *M. leei* and *M. lumi*, but apically more slender.

DESCRIPTION.— Body length 0.97–1.06, LII/SL 2.43–2.54 ($N = 4$). Color pale orange, abdomen yellowish with white bodies (gut diverticula) visible through integument; appendages yellowish-white. Body with areolate sculpturing throughout, lacking tubercles on scute and tergal margins; scute with 1 pair of AT. EM low and rounded, eyes absent, lacking retina and cornea. Palpal megaspines: trochanter 0; femur 3 ventrobasal, 1 mesodistal; patella 1 mesal, 1 ectal; tibia and tarsus each with 2 mesal, 2 ectal. TC, 3-4-4-4.

Male, holotype (paratype): Body length 0.97 (0.99). Scute length 0.69 (0.70), width 0.69 (0.69). EM length 0.18 (0.18), width 0.20 (0.20), height 0.10 (0.10). GO length 0.12 (0.12), width 0.13 (0.14). Leg II length 1.69 (1.71), LII/SL 2.44 (2.43). TrIV spur absent. GO rounded, subpentagonal. Penis VP entire, with 1 pair of long and 4 pairs short lateral setae, AS absent; glans with DL, PSL broadly pointed, weakly rugose; S short, sinuous.

Female, allotype (paratype): Body length 1.00 (1.06). Scute length 0.72 (0.73), width 0.76 (0.77). EM length 0.15 (0.17), width 0.18 (0.20), height 0.10 (0.10). GO length 0.11 (0.12), width 0.15 (0.16). Leg II length 1.84 (1.80), leg II/ scute length 2.54 (2.44). Genital operculum rounded, subpentagonal. Ovipositor surface sparsely set with microspines, apical teeth absent, with 7 pairs of apical setae, curved, trifurcate.

Sexual dimorphism.— The male has a larger eyemound.

NATURAL HISTORY.— Specimens have been collected from beneath serpentine rocks in *Euca-*

lyptus grassland. Current status of this species is uncertain due to destruction of the only known locality from construction at the San Francisco General Hospital.

MATERIAL EXAMINED.— CALIFORNIA: **San Francisco Co.:** San Francisco, Potrero Hill (Lot E of Potrero Avenue between 20th and 21st streets near Highway 101), beneath serpentine rocks in *Eucalyptus* grassland, 26 December 1990, by (T. Briggs, CAS), male holotype, female allotype, 1 male and 1 female paratypes.

DISTRIBUTION.— Known only from the type locality.

***Microcina sanbruno* Ubick and Briggs, sp. nov.**

Figures 9–10.

TYPE MATERIAL.— Male holotype from beneath serpentine rock in grassland, Serbian Ravine, San Bruno Mountain, San Mateo County, collected on 1 March 1992 by D. Ubick and T. Briggs, deposited at CAS.

ETYMOLOGY.— The species name is a noun in apposition taken from the type locality.

DIAGNOSIS.— Males of this species resemble those of *Microcina tiburona*, but differ in having a straighter stylus and narrower parastylar lobes.

DESCRIPTION.— Body length 0.92–1.09, LII/SL 1.94–2.82 (N = 8). Color pale orange, abdomen yellowish, with white bodies (gut diverticula) visible through integument; appendages yellowish-white. Body with areolate sculpturing throughout, with some larger tubercles along tergal margins; scute with 1 pair of AT. EM low and rounded, eyes absent, lacking retina and cornea. Palpal megaspinules: trochanter 0; femur 3 ventrobasal, 1 mesodistal; patella 1 mesal, 1 ectal; tibia and tarsus each with 2 mesal, 2 ectal. TC, 3-4-4-4.

Male, holotype (3 paratypes): Body length 1.09 (0.92–1.08). Scute length 0.78 (0.62–0.77), width 0.70 (0.58–0.67). EM length 0.22 (0.17–0.22), width 0.27 (0.20–0.25), height 0.10 (0.10–0.12). GO length 0.11 (0.11–0.12), width 0.13 (0.13–0.14). Leg II length 1.91 (1.64–1.87), LII/SL 2.45 (2.39–2.71). TrIV spur absent. GO subpentagonal. Penis VP entire, with 1 pair of long and 4 pairs short lateral setae, AS absent; glans with small DL, PSL broadly pointed; S long, weakly sinuous.

Female, allotype (3 paratypes): Body length 1.09 (0.95–0.98). Scute length 0.90 (0.62–0.72), width 0.72 (0.65–0.72). EM length 0.15 (0.14–0.15), width 0.19 (0.18–0.19), height 0.09 (0.10). GO length 0.11 (0.10–0.12), width 0.13 (0.13–0.14). Leg II length 1.75 (1.69–1.80), LII/SL 1.94 (2.35–2.82). GO rounded. Ovipositor surface sparsely set with microspines, apical teeth absent, with 7 pairs of apical setae, strongly curved, trifurcate.

Sexual dimorphism.— The male has a slightly larger eyemound.

NATURAL HISTORY.— Specimens have been collected from beneath serpentine and sandstone rocks in grassland and chaparral.

MATERIAL EXAMINED.— CALIFORNIA: **San Mateo Co.:** San Bruno Mountain, Buckeye Canyon, Indian Mound, under sandstone, 22 June 1991 (T. Briggs, CAS), 1 male, 1 female; Serbian Ravine, grassland, under serpentine, 1 March 1992, D. Ubick, T. Briggs, male holotype, female allotype, 1 male (SEM); Trail just N of ridge at first set of powerlines E of towers, ca 1000' el, chaparral, under sandstone, 11 May 1991 (D. Ubick, T. Briggs, CAS), 1 female (SEM); 18 Jan 1992 (D. Ubick, T. Briggs, W. Rauscher, CAS), 1 female; 26 Jan 1992 (D. Ubick, T. Briggs, W. Savary, CAS), 1 male. All specimens paratypes, unless indicated otherwise.

DISTRIBUTION.— Known only from San Bruno Mountain, San Mateo County.

***Microcina stanford* Ubick and Briggs, sp. nov.**

Fig. 11.

TYPE MATERIAL.— Male holotype from beneath basalt rock in oak grassland, at Stanford Antenna

Farm, east slope, E of Alpine Rd and Hwy 280, Santa Clara County, on 9 January 1998, by T.S. Briggs, deposited at CAS.

ETYMOLOGY.— The species name is a noun in apposition taken from the type locality.

DIAGNOSIS.— The male of this species has a very short stylus and most closely resembles that of *Microcina lumi*, but differs in having narrower PSL.

DESCRIPTION.— Body length 0.94–1.14, LII/SL 1.72–2.75 (N = 5). Color pale orange, abdomen yellowish-white. Appendages yellowish-white. Body with areolate sculpturing throughout, lacking tubercles on scute and tergal margins, scute with 1 pair of AT. EM low and rounded, eyes absent, lacking retina and cornea. GO rounded, pentagonal. Palpal megaspines: trochanter 0; femur 3 ventrobasal, 1 mesodistal; patella 1 mesal, 1 ectal; tibia and tarsus each with 2 mesal, 2 ectal. TC, 3-4-4-4.

Male, holotype (paratype): Body length 1.14 (0.94). Scute length 1.06 (0.73), width 0.76 (0.68). EM length 0.24 (0.21), width 0.24 (0.25), height 0.14 (0.12). GO length 0.12 (0.12), width 0.14 (0.14). Leg II length 1.82 (2.01), LII/SL 1.72 (2.75). TrIV spur absent. Penis VP entire, with 1 pair of long and 5 pairs short lateral setae, AS absent; glans with DL, PSL broadly pointed, weakly fringed; S short, sinuous.

Female, allotype (2 paratypes): Body length 1.00 (0.94–1.08). Scute length 0.70 (0.70–0.74), width 0.66 (0.66–0.75). EM length 0.16 (0.12–0.15), width 0.18 (0.20), height 0.10 (0.14). GO length 0.12 (0.10–0.13), width 0.14 (0.12–0.15). Leg II length 1.86 (1.66–1.87), LII/SL 2.66 (2.37–2.53). Ovipositor surface sparsely set with microspines, apical teeth absent, with 6 pairs of apical setae, curved, trifurcate, few setae with polyfurcate tips.

Sexual dimorphism.— The male eyemound is slightly larger.

NATURAL HISTORY.— Specimens have been collected from beneath basalt rocks in oak grassland.

MATERIAL EXAMINED.— CALIFORNIA: **Santa Clara Co.**: Stanford Antenna Farm, east slope, E of Alpine Rd and Hwy 280, oak grassland, under basalt rock, 9 January 1998 (T. Briggs, CAS), holotype male, allotype female, 7 male paratypes (SEM), 5 female paratypes (SEM).

DISTRIBUTION.—Known only from the type locality.

Microcina species

NOTE.— A male specimen from northern Marin County possibly represents a new species, although additional specimens are necessary to confirm this. It is mentioned here to document the northern range extension of the genus.

MATERIAL EXAMINED.— CALIFORNIA: **Marin Co.**: Novato, Rush Creek Preserve, volcanic hill, 8 March 2001 (T. Briggs, CAS), 1 male.

Sitalcina Banks, 1911

TYPE SPECIES: *Sitalces californica* Banks, 1893.

Sitalces (part) Banks, 1893:151.

Metapachylus Banks, 1909:230.

Sitalcina Banks, 1911:415. Goodnight and Goodnight, 1942:8. Briggs and Hom, 1966:262. Briggs, 1967:89; 1968:8. Rambla, 1969:397. Briggs and Ubick, 1989:207. Ubick and Briggs, 1989:96. Edgar, 1990:548. Kury, 2003:220.

Paramitraceras (part) Roewer, 1912:155.

Pachylicus (part) Roewer, 1923:118.

DIAGNOSIS.— *Sitalcina* differs from other phalangodids by the combination of penis having an

entire ventral plate, a folding glans (Fig. 16a), trough-like dorsal lobes (Fig. 16c) (but divided in *S. seca*), two (separate) parastylar lobes (Fig. 13), and an ovipositor with microspines in imbricate arrangement (Fig. 16i). Males differ from all Nearctic phalangodids with entire ventral plates in having a large ventral process (spur) ectally on trochanter IV (Figs. 15g–h).

DESCRIPTION.— Body length 1.25–2.50. Body finely rugose with variable number of larger tubercles scattered throughout, especially on tergite margins; scute with few to several AT. EM rounded to conical, eyes present. Cheliceral base with sloping dorsodistal swelling. Palpal megaspines: trochanter 1–2 small, femur 3 ventrobasal, 1 mesodistal; patella 1 mesal, 2 ectal; tibia and tarsus each 2 ectal, 2 mesal. TC, 3-5-5-5.

Male: Penis with VP entire, bearing several pairs of setae, AS lacking (except in *S. californica*); glans unfolds during expansion, with trough-like DL (divided in *S. seca*), with one pair of PSL; S variable in shape, lacking subapical tubule.

Female: Ovipositor cuticle with microspines in imbricate arrangement, apex lacking tooth, with 8 pairs of setae, hooked or sinuous, with simple or polyfurcate tips.

Sexual dimorphism: Male TrIV with ectoventral spur.

INCLUDED SPECIES.— To the previously described species, *S. borregoensis* Briggs, *S. californica* (Banks), *S. chalonga* Briggs, *S. flava* Briggs, *S. lobata* Goodnight and Goodnight, and *S. sura* Briggs, the following new species are here added: *S. catalina*, *S. peacheyi*, *S. rothi*, and *S. seca*.

DISTRIBUTION.— California and Arizona.

Key to the Species Groups of *Sitalcina*

1. Palpal Fm lacking dorsal tubercles (Figs. 15e–f); EM strongly conical, weakly tuberculate (Fig. 15a); male TrIV normal, ventroectally with 1 straight knobby spur (Figs. 15g–h); VP with AS (Fig. 16f); PSL unilobed (Figs. 16d–e); OV setae hooked, with pointed tips (Figs. 16g–h) *S. californica* group
Palpal Fm with dorsal tubercles; EM weakly conical to rounded, with variable tuberculation; male TrIV normal to elongate, ventroectal spur usually curved, if straight then not knobby; VP lacking AS; PSL bi- or tri- lobed; OV setae variable 2
2. Palpal Fm dorsal tubercles aetose (Figs. 21b–c); EM weakly tuberculate, subconical to rounded (Fig. 21a); male TrIV normal, with 1 (ectal) spur, curved to straight with rounded tip (Figs. 19e, 21d); PSL bilobed (Fig. 13); OV setae curved, with brush tips (Figs. 20f, j) *S. sura* group
Palpal Fm dorsal tubercles setose (Figs. 31c–e); EM strongly tuberculate, rounded (Fig. 31a–b); male TrIV enlarged, with 2 spurs, ectal pointed and forming loop (Figs. 31f–g); PSL trilobed (Figs. 32e–f); OV setae hooked, with pointed tips (Figs. 32g–h). *S. lobata* group

Characters for the *Sitalcina* species groups are given below, with the likely synapomorphies shown in bold. Apomorphies are identified on the basis of states that are apparently unique in the family (#1, 2, 3, 4, 5) or genus (6, 8, 9, 12), and by comparison with probable outgroups, *Microcinella* and *Microcina* (10, 11). Some of these characters are further discussed in the Phylogeny section.

	<i>californica</i> group	<i>sura</i> group	<i>lobata</i> group
1. PFm dorsomesal tubercle row	absent	present	absent
2. PFm dorsal setose tubercles	absent	absent	present
3. TrIV length	normal	normal	elongate
4. TrIV ectal spur	straight	curved -straight	looped
5. TrIV ectal spur tip	rounded	rounded	pointed
6. TrIV mesal spur	absent	absent	present
7. EM shape	strongly conical	subconic-round	rounded
8. EM tuberculation	weak	weak	strong
9. VP AS	present	absent	absent
10. PSL form	unilobed	bilobed	trilobed
11. OVS shape	hooked	curved	hooked
12. OVS tip	pointed	brush	pointed

Sitalcina californica Group

DIAGNOSIS.— The single species representing this group, *Sitalcina californica*, is easily recognized by its distinctive eyemound: large, conical, and anteriorly projecting (Fig. 15a–c). Unlike other *Sitalcina*, the palpal femur lacks dorsal tubercles (Fig. 15e–f), and the male differs in having a penis with a pair of apical spines on the ventral plate (Fig. 16b, f) and a TrIV spur that is relatively straight and bears an ectal knob (Fig. 15g–h).

INCLUDED SPECIES.— Only *S. californica* (Banks).

DISTRIBUTION.— Central Coast Ranges of California.

Sitalcina californica (Banks, 1893)

Figures 1, 2d, 3d, 14a–c, 15–16.

Sitalces californica Banks, 1893:151; 1901:672; 1904:363; 1911:415.

Sitalcina californica, Banks, 1911:415.

Sitalcina californicus, Goodnight and Goodnight, 1942:8. Briggs and Hom, 1966: 263. Briggs, 1967:89; 1968:10. Edgar, 1990:548.

Paramitraceras californicus, Roewer, 1912:155.

Pachylicus californicus, Roewer, 1923:118.

Sitalcina californica, Ubick and Briggs, 1989:89. Kury, 2003:220.

TYPE MATERIAL.— Female holotype from Southern California ("So. Calif."), Nathan Banks Coll., at MCZ (#14679), examined. Although the holotype is a female, it is unusual in having well developed TrIV spurs, uniquely so of the specimens examined. Although extraction of the genitalia was not attempted, due to the brittleness of the type, examination through the genital opening reveals an ovipositor with its characteristic crossed setae. The TrIV spurs are shorter and more slender than in males. Similarly "masculinized" females (2 specimens) were observed in another phalangodid, *Texella reyesi* Ubick & Briggs (1992:211).

DIAGNOSIS.— Same as for species group.

DESCRIPTION.— Body length 1.40–1.96, LII/SL 2.65–3.10 (N = 10). Color orange to orange-brown, appendages lighter orange, tarsi whitish. Body dorsum finely rugose, with larger tubercles along median line to eyemound, in transverse rows on scute, and along tergal margins; scute with 3–6 pairs of AT. EM large, conical, anteriorly directed, with some larger tubercles, especially at apex; eyes present. GO rounded, subrectangular. Palpal femur with dorsal row of 3–5 setae. Palpal megaspinous: trochanter 0; femur 3 ventrobasal, 1 mesodistal; patella 2 mesal, 1 ectal; tibia 2 mesal (with 3rd represented by distal setose tubercle), 2 ectal; tarsus 2 mesal, 2 ectal. TC, 3-5-5-5.

Male (N = 6): Body length 1.40–1.90. Scute length 1.04–1.30, width 1.10–1.34. EM length

0.26–0.41, width 0.26–0.40, height 0.23–0.40. GO length 0.15–0.22, width 0.18–0.20. Leg II length 3.22–3.72, LII/SL 2.77–3.10. TrIV spur a straight rounded process with ectal knob, length from 0.5–1.0 trochanter diameters. Penis VP subtriangular, entire with rounded apical projection, with 8–10 pairs of lateral setae, short AS present; glans with trough-like DL, roughly square in shape, PSL trough-like, apically rounded and with small ventrodistal ornamentation; S short, straight, pointed and with laterobasal sculpturing.

Female holotype (additional specimens, N = 4): Body length 1.80 (1.40–1.96). Scute length 1.14 (1.10–1.20), width 1.30 (1.26–1.34). EM length 0.37 (0.26–0.34), width 0.32 (0.30–0.32), height 0.30 (0.26–0.38). GO length 0.15 (0.16–0.18), width 0.20 (0.20–0.22). Leg II (missing in holotype) length ? (3.18–3.44), LII/SL ? (2.65–3.00). TrIV lacking ventral tubercle. Ovipositor of two segments, basal finely wrinkled, distal with microspines in imbricate pattern; with 7–8 pairs of setae, apically hooked, pointed.

Sexual dimorphism.— The male has a TrIV spur which is usually absent in females, except the aberrant holotype.

Variation.— Individuals vary in the degree of tuberculation. Larger males have more robust and strongly bent TrIV spurs. Males also show slight differences in the ornamentation of the PSL. The TrIV spur on the female holotype appears to be unique in the sample studied.

NATURAL HISTORY.— Most specimens have been collected in forest biomes, including both coniferous and broadleaf evergreen forests, from beneath rocks, in decomposing wood, and in leaf litter. These harvestmen can be quite common, especially in redwood forests. Individuals of both sexes, as well as juveniles, have been collected throughout the year.

Several individuals were kept in the lab and maintained on a diet of collembola and/or mites for several weeks. (J. Cokendolpher, pers. comm.)

MATERIAL EXAMINED.— CALIFORNIA: **Mendocino Co.:** 2.0 mi N Albion along Hwy 1, pine-tanoak forest, under logs and crumbly sandstone, 20 July 1990 (D. Ubick, CDU), 3 males, 3 females, 1 juvenile; Big River, ca 2 mi W James Creek on Hwy 20, under redwood logs, 19 July 1990 (D. Ubick, CDU), 2 males, 3 females, 2 juveniles; redwood duff, 5 May 1991 (D. Ubick, CDU), 3 males, 4 females; Cameron Road, 0.1 mi NW Philo Greenwood Road, redwood duff, 3 May 1991 (D. Ubick, CDU), 5 males, 5 females; Camp Dunlap, redwood forest, 25 July 1993 (J. Boutin, CDU), 3 males, 1 female, 1 juvenile; 2 August 2006 (D. Ubick, CAS), 9 males, 2 females; Caspar, 7 March 1954 (J. Helfer, AMNH), 7 males, 3 females [collected with *Calicina sequoia*]; Dimmick State Recreation Area, under redwood log, 7 December 1968 (V. Lee, CAS), 1 male; Faulkner County Park, redwood duff, 3 May 1991 (D. Ubick, CDU), 3 males, 1 female; Highway 128, ca. 5 km E Hwy 1, N39°10.2', W123°42', redwood forest, 3 August 2006 (D. Ubick, CDU), 1 male, 1 female; Jackson State Forest, 0.5 mi W Camp Dunlap, el 400', redwood duff, 16 September 1990 (D. Ubick, CDU), 1 male; 0.5 mi W Dunlap Pass along Big River, under redwood logs, 19 July 1990 (D. Ubick, CDU), 1 female; 20 July 1990 (D. Ubick, CDU), 1 male, 3 females, 1 juvenile; 15 mi W Willits on Hwy 20, N39°20.84', W123°30.87', sifting redwood duff, 27 May 2005 (D. Ubick, CDU), 1 male, 1 female, 1 juvenile; James Creek at Hwy 20, 19 April 1971 (A. Jung, CAS), 1 male, 2 females; Little River, 7 June 1955 (J. Helfer, UCB), 1 male; 11 June 1955 (J. Helfer, UCB), 1 male; 3 August 1957 (G. Marsh, J. Helfer, UCB), 2 males, 4 females; 1.5 mi S-SE Little River, 3 July 1966 (T. Briggs, V. Lee, K. Hom, CAS), 4 females, 2 juveniles; MacKerricher State Park, berlese ex *Alnus* litter, 7 November 1976 (J. Doyen, UCB), 3 males, 1 female; Mendocino, 25 July 1954 (J. Helfer, AMNH), 4 males, 10 females [collected with *Calicina sequoia* and *Metanonychus* sp.]; 10 October 1954 (J. Helfer, AMNH), 4 males, 2 females; 4 July 1955 (J. Helfer, UCB), 2 males; 3 March 1957 (J. Helfer, AMNH), 2 females; in redwood duff, 4 May 1963 (no collector, CAS), 1 male; N of Mendocino, humus nr swamp, 6 July 1957 (J. Helfer, R. Schuster, UCB), 3 males, 1 female; Mendocino Woodlands, S end nr Big River, el 80', redwood duff, 16 September 1990 (D. Ubick, CDU), 6 males, 6 females; under redwood logs, 17 September 1990 (D. Ubick, CDU), 1 juvenile; Montgomery Woods State Reserve, old growth redwood forest, under logs, 21 July 1990 (D. Ubick, CDU), 1 female, 1 juvenile; same collection, but in redwood duff, 1 male, 1 female; Mushroom Corners, berlese ex Douglas fir litter, 10 November 1974 (T. Ham-

mer, CAS), 1 female; Ryan Creek, 8 November 1951 (J. MacSwain, UCB), 1 male; no date (no collector, UCB), 1 male, 1 female; nr E entrance Standley State Park, 4 July 1966 (T. Briggs, V. Lee, K. Hom, CAS), 5 males, 2 females, 1 juvenile; Tranquility, 1.5 mi S Caspar, riparian litter, 17 September 1990 (D. Ubick, CDU), 2 males, 1 female; 18 September 1990 (D. Ubick, CDU), 2 males, 2 females; same collection but from tanoak-bishop pine litter, 2 males, 2 females; same collection but from mossy leaf mold in pine forest, 6 males, 1 female; same collection but from bishop pine duff, 8 males, 5 females; redwood duff, 3 May 1991 (D. Ubick, CDU), 2 males, 3 females; under pine-tanoak logs, 4 May 1991 (D. Ubick, CDU), 2 females; same collection but from pine litter, 6 males, 5 females; same collection but under rocks in pine forest, 1 female; berlese of redwood-tanoak litter, 5 May 1991 (D. Ubick, CDU), 2 females, 1 juvenile; Van Damme State Park, Fern Canyon, under redwood logs, 21 July 1990 (D. Ubick, CDU), 4 males, 1 juvenile; 4 mi N Yorkville, under redwood log, 2 March 1968 (T. Briggs, CAS), 1 male, 3 females; [no locality], 23 July 1955 (J. Helfer, AMNH), 2 females. **Sonoma Co.:** Annapolis, 23 February 1955 (J. Helfer, AMNH), 1 male; 1.5 mi E junction Annapolis and Skaggs Springs roads, 18 April 1971 (A. Jung, CAS), 1 male, 1 female; nr Armstrong Redwoods State Park, under rocks and logs, 12 February 1966 (T. Briggs, CAS), 1 male, 1 female; 1 mi N Camp Meeker, redwood forest, under serpentine, 12 Mar 1967 (T. Briggs, CAS), 4 females; 2.1 mi NW Camp Meeker, el 90m, 14 January 1983 (T. Briggs, V. Lee, D. Ubick, CAS), 4 males, 2 females, 4 juveniles; 0.2 mi N Camp Meeker, 12 December 1985 (V. Lee, L. Zinn, CAS), 1 male; 3.5 mi W El Verano, Canyon Drive at Deer Park Drive, 11 February 1983 (T. Briggs, V. Lee, D. Ubick, CAS), 18 males (SEM), 29 females, 20 juveniles; broadleaf forest, under volcanic rocks, 6 February 1988 (T. Briggs, V. Lee, D. Ubick, CAS), 1 male, 3 females; near El Verano, junction of Spring and Prospect roads at Diamond Estates Recreation Area, 18 January 1988 (T. Briggs, CAS), 4 males, 3 females, 1 juvenile; 3.5 mi W El Verano, grassland, under volcanic rocks, 6 February 1988 (D. Ubick, T. Briggs, CDU), 1 female, 5 juveniles; 4.1 mi SE Ft. Ross Historical State Park, 3 July 1966 (T. Briggs, V. Lee, A. Jung, K. Hom, CAS), 8 males, 7 females, 1 juvenile; Franz Creek, just E of Chalk Hill Road, redwood forest, under logs, 12 April 1990 (D. Ubick, T. Briggs, W. Rauscher, B. Lym, CAS), 1 male; Glen Ellen, 15 February 1954 (V. Roth, R. Schuster, AMNH), 1 male, 1 female; 8 mi N Guerneville, 18 August 1959 (V. Roth, W. Gertsch, AMNH), 1 male; Harrison Grade Road nr Green Valley Road, redwood forest, under logs, 12 April 1990 (D. Ubick, T. Briggs, W. Rauscher, B. Lym, CAS), 3 females; Healdsburg, 11 January 1981 (T. Briggs, CAS), 2 males; 1.5 mi E Healdsburg on Bailache Avenue, broadleaf evergreen forest, under volcanic rocks, 27 December 1980 (D. Ubick, CDU), 1 male; oak leaf litter, 29 March 1981 (D. Ubick, CDU), 1 female; 15 June 1981 (D. Ubick, CDU), 2 males, 1 female, 1 juvenile; 21 December 1981 (D. Ubick, CDU), 1 female; 13 January 1991 (D. Ubick, W. Savary, K. Dabney, CDU), 3 males, 9 females; same as previous but from berlese of moss, 1 male; Jenner, redwood forest, under serpentine, 12 March 1967 (K. Hom, T. Briggs, CAS), 4 males, 2 females; nr Lytton, 1.6 mi W Soda Rock Lane from Alexander Valley Road, 25 February 1968 (T. Briggs, CAS), 3 females; W of Mark West Reservoir, douglas fir litter, 22 January 1958 (F. Raney, R. Schuster, UCB), 2 females, (AMNH), 2 males, 2 females; Mark West Springs, 31 December 1953 (G. Marsh, V. Roth, R. Schuster, AMNH), 1 male, 2 females; SE of Monte Rio, Bohemian Highway, 0.3 mi N of Main St., 9 January 2007, N38°27', W122°59', oak-douglas fir forest, under metamorphic rocks (D. Ubick, T. Briggs, CDU), 1 male, 2 females; 2 mi due SW Occidental, 7 January 1967 (T. Briggs, A. Lee, CAS), 5 males, 1 juvenile; 0.15 mi E Occidental, N of Graton Road, redwood forest, under schist, 12 April 1990 (D. Ubick, T. Briggs, W. Rauscher, B. Lym, CAS), 3 males, 6 females, 4 juveniles; 4 mi NE Penngrove, 26 November 1965 (J. Buckett, UCD), 2 males, 4 females; Plantation, 23 February 1955 (J. Helfer, AMNH), 1 female; 0.3 mi W Plantation, sifting redwood litter, 12 February 1966 (T. Briggs, K. Hom, D. Owyang, CAS), 5 males, 2 females; same collection but from under rocks and logs (T. Briggs, K. Hom, A. Jung, CAS), 4 males, 3 females; Salt Point State Park, Wildcat Creek, el 400', redwood duff, 22 September 1990 (D. Ubick, CDU), 10 males, 9 females; 8 mi N Santa Rosa, nr bridge on Chalk Hill Road, 5.8 mi NE junction Pleasant and Chalk Hill avenues, 21 May 1966 (T. Briggs, V. Lee, K. Hom, CAS), 3 males, 5 females, 1 juvenile; Seaview, 23 February 1955 (J. Helfer, AMNH), 1 male; Sebastopol, leaf mould (R. Darby, AMNH), 2 females; Sonoma Mountain, end of Sonoma Mountain Road, 18 January 1988 (T. Briggs, CAS), 1 female; 1 mi E Stewart's Point, redwood forest, under rocks, 12 February 1966 (K. Hom, A. Jung, CAS), 1 male, 2 females; 7.4 mi SE Stewart's Point, 3 July 1966 (T. Briggs, V. Lee, CAS), 1 female; 8.9 mi SE Stewart's Point, 3 July 1966 (T. Briggs, V. Lee, CAS), 1 female; 13.4 mi SE Stewart's Point, 3 July 1966 (V. Lee, CAS), 1 male, 1 female; 1 mi S Trenton, 15 May 1957 (R. Schuster, UCB), 2 females. **Napa**

Co.: Mount St. Helena, 31 December 1953 (G. Marsh, R. Schuster, V. Roth, AMNH), 1 female; 7 mi W Oakville, oak-redwood duff, 13 December 1957 (L. Smith, R. Schuster, AMNH), 3 males, 1 female; 15 February 1954 (V. Roth, R. Schuster, AMNH), 3 males. **Marin Co.:** 1.8 mi SW Alpine Dam, under rock, 27 January 1966 (K. Hom, T. Briggs, CAS), 1 female; 3 mi NE Alpine Dam, Alpine Lake, under rocks, 27 January 1966 (A. Jung, K. Hom, P. Chin, CAS), 2 males, 4 females; Bolinas, 24 March 1960 (R. Schuster, AMNH), 2 females; Bolinas Ridge, N of Toll Station, under rocks, 5 December 1965 (V. Lee, CAS), 1 female; 13 August 1965 (V. Lee, T. Briggs, CAS), 3 females; 1 January 1966 (T. Briggs, CAS), 1 female; nr Bootjack Camp, along Bootjack Trail, undersurface of redwood log, 27 January 1973 (T. Briggs, R. Lem, CAS), 1 male, 2 females; Inverness, 8 November 1953 (G. Marsh, R. Schuster, AMNH), 1 male; 1 mi S Inverness, berlese bishop pine duff, 12 March 1966 (C. O'Brien, UCB), 1 female; 25 December 1966 (C. O'Brien, UCB), 1 male, 1 female; berlese douglas fir duff, 25 December 1960 (C. O'Brien, UCB), 2 males; 30 January 1959 (D. Linsdale, UCB), 2 males, 8 females, 2 juveniles; 1 mi SE Inverness, douglas fir duff, 8 January 1961 (C. O'Brien, UCB), 1 female; 1 mi W Inverness, 1 March 1960 (Grigarick, Smith, R. Schuster, AMNH), 1 male; 2 air mi W Inverness, berlese of *Alnus rubra* litter, 1 May 1976 (J. Doyen, UCB), 4 males, 3 females; Lake Lagunitas, 19 July 1966 (T. Briggs, CAS), 1 male, 1 female; under rocks, 5 February 1966 (K. Hom, CAS), 2 males; Lily Lake, E of Alpine Lake, berlese of redwood litter, 23 November 1966 (V. Lee, CAS), 1 male, 3 females; Mill Valley, forest duff, 27 May 1952 (H. Leech, CAS), 1 male, 1 female; sifting forest floor, 30 May 1952 (H. Leech, CAS), 14 males, 20 females; 28 May 1952 (H. Leech, CAS), 4 males, 3 females, 4 juveniles; 3 June 1952 (H. Leech, CAS), 1 male, 5 females, 1 juvenile; sifting old *Neotoma* nest, 14 June 1952 (H. Leech, CAS), 2 males, 1 female; 9 July 1952 (H. Leech, CAS), 5 females; sifting debris under trees, June 1952 (H. Leech, CAS), 11 males, 39 females, 6 juveniles; 2 September 1953 (G. Marsh, R. Schuster, AMNH), 10 males, 18 females, 1 juvenile; Mount Tamalpais State Park, 0.7 mi due N Muir Woods N. M. on Old Railroad Grade, redwood forest, under rocks, 31 May 1968 (V. Lee, CAS), 1 male, 3 females; Muir Woods, 5 September 1927 (no collector, AMNH), 1 male; nr Muir Woods, 21 August 1965 (T. Briggs, V. Lee, CAS), 4 females; Fern Creek, undersurface of redwood log, 27 January 1973 (T. Briggs, R. Lem, CAS), 1 male; 0.3 mi N Muir Woods, redwood litter, 21 August 1965 (T. Briggs, K. Hom, V. Lee, D. Owyang, CAS), 1 male, 1 female; 1 mi SE Nicasio, under redwood log, 10 February 1968 (K. Hom, G. Leung, CAS), 1 male, 1 female; Novato, saddle SW Burdell Mountain, el 550', oak forest, under serpentine, 2 January 1986 (T. Briggs, D. Ubick, CAS), 1 female; Paradise Valley, 2 mi NW Bolinas, redwood litter, 22 March 1966 (C. O'Brien, UCB), 4 males, 4 females, 1 juvenile; Phoenix Lake, 14 May 1966 (V. Lee, CAS), 2 males, 4 females, 5 juveniles; Point Reyes, 14 February 1980 (R. Kimsey, R. Schuster, UCD), 1 male, 2 females; Point Reyes, 0.5 mi E entrance to park, thick riparian, under rock, 24 February 1979 (D. Ubick, CAS), 1 female; Point Reyes, Mt. Whittenburg, 12 November 1972 (T. Briggs, CAS), 4 females; Point Reyes, Redwood Grove, nr Dogtown, 10 July 1982 (T. Briggs, CAS), 1 male; 6 mi E Point Reyes Station, 1 March 1960 (Grigarick, Smith, R. Schuster, AMNH), 1 female; Ross, Bald Hill, 1 March 1991 (D. Ubick, T. Briggs, CAS), 2 males, 1 female, 4 juveniles; 1.8 mi E Stinson Beach on Panoramic Hwy, 3 July 1966 (T. Briggs, A. Jung, K. Hom, CAS), 1 female, 1 juvenile; San Geronimo, W122.42°, N37.59°, 27 September 1963 (J. W. Ivie, AMNH), 2 females; Taylor State Park, 24 October 1953 (V. Roth, AMNH), 1 male, 1 female; berlese redwood duff, 19 December 1966 (C. O'Brien, UCB), 2 males, 2 females, 2 juveniles; 12 June 1993 (D. Ubick, CDU), 5 males, 8 females, 5 juveniles; 1 mi S Taylor State Park, redwood duff, 17 January 1959 (C. O'Brien, UCB), 1 male. **San Mateo Co.:** 7 mi S Crystal Springs Dam, redwood grove, under sandstone, 19 February 1966 (T. Briggs, V. Lee, CAS), 1 male, 2 females; 6 mi SE Half Moon Bay, 1 June 1957 (R. Schuster, UCB), 10 males, 9 females; 21 July 1957 (R. Schuster, UCB), 4 males, 5 females; Kings Mountain, 1 September 1958 (R. Schuster, UCB), 1 male; 8 February 1959 (R. Schuster, UCB), 1 male, 3 females; 16 October 1994 (D. Ubick, CAS), 1 male; 1.0 mi N La Honda, along La Honda Creek, redwood-douglas fir duff, 16 May 1991 (D. Ubick, CDU), 3 males, 1 female; Linda Mar, coastal scrub, ex fern litter, 17-18 February 1967 (T. Briggs, V. Lee, CAS), 4 males, 8 females; Pilarcito Lake, berlese of *Adenostoma* and *Arctostaphylos*, 17 February 1964 (C. O'Brien, UCB), 3 males; berlese, 27 February 1966 (C. O'Brien, UCB), 2 males, 3 females, 1 juvenile; San Bruno Mountain, 19 December 1970 (T. Briggs, CAS), 2 males, 3 females; Crystal Cave Canyon, dense *Ceanothus* forest, under rock, 20 July 1982 (D. Ubick, CDU), 1 male; Owl Canyon, 20 March 1994 (D. Ubick, T. Briggs, W. Rauscher, CAS), 1 female, 1 juvenile; trail at power line, ca 1000' el, dense chaparral, under sandstone, 10-11 May 1991 (D. Ubick, T. Briggs, CDU), 4 males, 1 female,

3 juveniles; Serbian Ravine, 1 March 1992 (D. Ubick, T. Briggs, CAS), 2 juveniles; San Pedro Valley County Park, riparian canyon, under sandstone, 18 May 1991 (D. Ubick, CDU), 1 male, 1 juvenile; Skyline Boulevard, 1 mi NW Kings Mountain, redwood duff, 29 June 1990 (D. Ubick, CDU), 4 males, 3 females. **Santa Cruz Co.:** Big Basin, 23 December 1953 (V. Roth, AMNH), 4 males, 3 females; Cave Gulch, under rock, 17 November 1966 (T. Briggs, CAS), 1 male, 2 females; 18 June 1984 (T. Briggs, D. Ubick, CAS), 4 males (SEM), 3 females; Bat Cave, under rocks, 11 June 1966 (T. Briggs, V. Lee, CAS), 1 male, 2 females; 21 April 1979 (D. Rudolph, S. Winterath, E. vanIngen, D. Cowan, CAS), 1 male; near Dolloff Cave, 19 March 1966 (T. Briggs, K. Hom, CAS), 2 males; 0.25 mi S Dolloff Cave, 19 March 1966 (T. Briggs, K. Hom, CAS), 1 male, 3 females; Empire Cave, under rock in cave, 24 June 1990 (D. Ubick, CDU), 1 male; Empire Grade Rd., 18 February 1991 (D. Ubick, CJC), 1 male, 2 females, 1 juvenile; IXL Cave, 21 April 1979 (D. Rudolph, D. Cowan, E. van Ingen, S. Winterath, CAS), 2 males, 1 female, 1 juvenile; Stearns Cave, 21 April 1979 (D. Rudolph, D. Cowan, S. Winterath, E. van Ingen, CAS), 2 males, 1 juvenile; Stump Cave, 17 November 1966 (T. Briggs, CAS), 1 male, 1 female; 21 April 1979 (D. Rudolph, B. Martin, E. van Ingen, S. Winterath, D. Cowan, CAS), 2 males, 1 juvenile; 27 July 2001 (D. Ubick, CDU), 2 males; 22 January 2005 (D. Ubick, CDU), 1 female; Soquel, Grover Glade, redwood forest, 3 May 1980 (S. Muzzio, CDU), 1 female. **Alameda Co.:** Berkeley, 17 November 1947 (J. MacSwain, UCB), 1 male, 1 juvenile; 17 December 1947 (J. MacSwain, CJC), 3 males, 3 females; 9 May 1948 (J. MacSwain, UCB), 1 male, 4 females, 2 juveniles; Chabot Road, 0.6 mi E MacArthur Boulevard, 4 December 1966 (V. Lee, CAS), 1 male, 1 female; 1.5 mi NE Crow Canyon Road, 22 January 1984 (T. Briggs, D. Ubick, CAS), 1 female, 4 juveniles; Niles, canyon off Niles Canyon, 1 January 1964 (V. Roth, AMNH), 1 female; Oakland, 14 June 1953 (R. Schuster, AMNH), 2 females; Oakland, Mountain Boulevard at Park, 17 October 1953 (V. Roth, R. Schuster, AMNH), 1 male; Redwood Regional Park, in redwood litter, 13 February 1976 (J. Doyen, UCB), 2 females; Redwood Road at Grizzly Peak Boulevard, 4 May 1985 (T. Briggs, T. Ohsumi, CAS), 2 females; Ward Canyon at Campus Drive, near Hayward State University, 10 May 1999 (T. Briggs, CAS), 1 male, 1 female, 2 juveniles; Woolsey Canyon, Berkeley, end of LeConte Street, under bark dead bay tree, 27 October 1946 (J. MacSwain, CJC), 1 male; 21 December 1983 (T. Briggs, V. Lee, D. Ubick, CAS), 1 male, 2 females, 7 juveniles; S side Woolsey Canyon, 17 February 1960 (A. Gray, AMNH), 1 male. **Contra Costa Co.:** 2 mi W Moraga, Canyon at Pinehurst Road, redwood litter, 19 August 1965 (T. Briggs, V. Lee, CAS), 1 male, 4 females; Moraga Redwoods, at end of Pinehurst Road, 26 May 1985 (T. Briggs, T. Ohsumi, CAS), 5 males, 2 females, 3 juveniles; nr Richmond, Wildcat Creek at Hill Road, 30 January 1984 (T. Briggs, CAS), 2 males, 4 juveniles. **San Benito Co.:** 3 mi NW San Juan Bautista, oak woodland, under rocks, 28 February 1967 (V. Lee, CAS), 1 male, 1 female; **San Luis Obispo Co.:** 3 mi SW Atascadero, oak forest, under rocks, 25 March 1967 (T. Briggs, V. Lee, CAS), 1 male, 4 females; San Luis Obispo, 4 January 1953 (no collector, AMNH), 1 male; 1.1 mi W San Luis Obispo on Perfumo Road, oak forest, under rocks, 26 February 1967 (V. Lee, CAS), 1 female; 1 mi W Los Osos Valley Road on Perfumo Canyon Road, el. 60 m, live oak forest, berlese leaf litter, 14 February 1987 (T. Briggs, V. Lee, CAS), 5 males, 16 females, 5 juveniles.

DISTRIBUTION.— This widespread species ranges from Mendocino County south to San Luis Obispo.

Sitalcina sura Group

DIAGNOSIS.— This species group differs from other *Sitalcina* in having the palpal femur armed with asetose tubercles: one mesally and a short row dorsally (Figs. 21b–c). The male has a penis with the ventral plate lacking an apical spine (Fig. 13) and trochanter IV with a single, typically curved, ectal process (Figs. 19e, 21d, 26b–g); the female ovipositor has microspines in imbricate arrangement (Fig. 24f), except in some *S. seca* and *S. sura* (Figs. 18f, 20g), and curved setae with polyfurcate tips (Figs. 20f, j).

INCLUDED SPECIES.— *S. borregoensis* Briggs, *S. chalona* Briggs, *S. flava* Briggs, and *S. sura* Briggs, and the new species: *S. catalina*, *S. peacheyi*, *S. rothi*, and *S. seca*.

DISTRIBUTION.— Central to southern Coast Ranges, California, and southeastern Arizona.

***Sitalcina sura* Briggs, 1968**

Figures 2c, 3c, 13a–b, 17–18.

Sitalcina sura Briggs, 1968:17. Kury, 2003:220.

TYPE MATERIAL.—Female holotype collected from beneath rocks in redwood forest at Big Sur, Monterey County, California, on 20 March 1966, by T. Briggs and K. Hom, deposited at CAS, examined.

DIAGNOSIS.—This species differs from others in the group by its distinctive male genitalia, with large apically ornate parastylar lobes and extremely short setae on the ventral plate. The female ovipositor cuticle is only weakly imbricate to glabrous. Somatically, *S. sura* most closely resembles *S. seca*, from which it may be distinguished by its larger size and much larger genitalia: *S. sura* has a scute length of 1.30–1.54 (1.10–1.32 in *S. seca*) and a GO width of 0.32–0.39 (0.22–0.26 in *S. seca*).

DESCRIPTION.—Body length 2.00–2.50, LII/SL 2.90–3.60 (N = 13). Color orange-brown, appendages lighter. Body finely rugose, with scattered larger tubercles on tergite margins, along scute posterior, and on eyemound, particularly along anterior face; scute with 3–5 pairs of AT. EM subconical, eyes present. GO rounded, subtriangular. Palpal femur with median dorsobasal row of 3–5 small asetose tubercles and 1 mesal tubercle. Palpal megaspinules: trochanter 1, small; femur 3 ventrobasal (and 2 tubercles), 1 mesodistal (and 1 tubercle); patella 2 mesal, 1 ectal; tibia 3 mesal, 2 ectal; tarsus 2 mesal, 2 ectal. TC, 3-5-5-5.

Male, allotype (additional specimens, N = 5): Body length 2.14 (2.14–2.50). Scute length 1.30 (1.40–1.54), width 1.50 (1.50–1.70). EM length 0.30 (0.30), width 0.33 (0.30–0.35), height 0.27 (0.22–0.25). GO length 0.28 (0.28–0.32), width 0.33 (0.32–0.37). Leg II length 4.28 (4.38–5.14), LII/SL 3.30 (3.10–3.60). TrIV spur present, short, stout, curved. Penis VP apically truncate, apical surface with 14–16 short setae, AS absent; glans large, with long rectangular DL, PSL broadly spatulate, ridged mesally, ornate apically; S not visible, presumed to be short.

Female, holotype (additional specimens, N = 6): Body length 2.20 (2.00–2.20). Scute length 1.44 (1.30–1.46), width 1.60 (1.54–1.74). EM length 0.33 (0.27–0.30), width 0.36 (0.30–0.33), height 0.30 (0.22–0.25). GO length 0.31 (0.29–0.34), width 0.36 (0.35–0.39). Leg II length 4.14 (4.10–4.66), LII/SL 2.90 (3.15–3.30). Ovipositor surface with microspines weak to absent, apex lacking teeth, with 6 pairs of curved apical setae, 1 pair ventral subapical, setal tips polyfurcate.

Sexual dimorphism.—The male has a TrIV spur.

Variation.—Ovipositor microspines are reduced in this species, being absent in some individuals.

NATURAL HISTORY.—This species occurs in redwood forests and adjacent woodlands, where it is common in leaf litter, as well as in decaying wood and beneath rocks. It has been collected from December to August, and is probably active year-round.

MATERIAL EXAMINED.—CALIFORNIA: **Monterey Co.:** Big Sur (Type Locality), redwood forest, under rocks, 20 March 1966 (T. Briggs, K. Hom, CAS), 1 male allotype, 1 female holotype; Big Sur, nr Pfeiffer Falls, redwood forest, under log, 2 July 1967 (T. Briggs, T. Lee, L. Lee, G. Leung, CAS), 1 male; nr Big Sur State Park, 20 March 1966 (T. Briggs, K. Hom, CAS), 2 males, 4 females, 3 juveniles; 7 mi S Big Sur, 22 December 1953 (V. Roth, UCB), 2 males; Bixby Canyon, maple duff, 23 February 1959 (E. Lindquist, UCB), 3 males, 3 females, 1 juvenile; Bixby Canyon Road, 3.5 mi E Hwy 1, redwood forest, under log, 9 July 1967 (T. Briggs, CAS), 1 male; False Point Sur, under Monterey pine logs, 20 March 1966 (T. Briggs, K. Hom, CAS), 3 females; Ghost Cave, SE side of Pico Blanco, el 550 m, 22 August 1982 (T. Briggs, V. Lee, CAS), 2 females; Pfeiffer Big Sur State Park, redwood duff, 8 June 1972 (E. Fisher, UCR), 4 females; Ventana Camp, 13 April 1976 (T. Briggs, K. Hom, CAS), 5 males (SEM), 4 females (SEM).

DISTRIBUTION.—Known only from coastal Monterey County, California.

***Sitalcina seca* Ubick and Briggs, sp. nov.**

Figures 13c–d, 19–20.

TYPE MATERIAL.— Male holotype and female allotype collected from beneath granite rocks at talus slope SW of Lakes at Arroyo Seco Campground, Monterey County, California, on 6 May 1995, by D. Ubick and W. Savary, deposited at CAS.

ETYMOLOGY.— The name refers to the type locality, Arroyo Seco.

DIAGNOSIS.— This species differs from others in the group by its distinctive male genitalia, the divided dorsal lobe and large spatulate parastylar lobes. The female ovipositor cuticle lacks microspines or is only weakly imbricate. Somatically, *S. seca* most closely resembles *S. sura*, from which it may be distinguished by its smaller size and much smaller genitalia (see diagnosis of *S. sura*).

DESCRIPTION.— Body length 1.66–2.20, LII/SL 3.25–4.33 (N = 8). Color orange-brown, appendages lighter. Body covering of fine tubercles, larger tubercles along tergal margins and on anterior slope of scute and eyemound; scute with 3 to 4 pairs of AT. EM subconical, eyes present. GO rounded, subtriangular. Palpal femur with median dorsobasal row of 4 long tubercles and 1 mesal tubercle. Palpal megaspines: trochanter 1, small; femur 3 ventrobasal, 2 mesodistal; patella 2 mesal, 1 ectal; tibia 2 mesal (and 1 distal seta), 2 ectal; tarsus 2 mesal, 2 ectal. TC, 3-5-5-5.

Male, holotype (other specimens, N = 3): Body length 2.00 (1.90–2.20). Scute length 1.26 (1.12–1.32), width 1.34 (1.28–1.40). EM length 0.28 (0.26–0.30), width 0.30 (0.26–0.30), height 0.26 (0.22–0.25). GO length 0.22 (0.22–0.25), width 0.26 (0.22–0.25). Leg II length 5.19 (4.10–5.14), LII/SL 4.12 (3.40–4.05). TrIV spur present, short stout and strongly curved. Penis VP entire with rounded apical extension, with about 17 pairs of medium length setae, AS absent; glans with divided DL, PSL large, spatulate; S not fully interpreted, but appears to be a slender prong.

Female allotype (other specimens, N = 3): Body length 1.74 (1.66–2.10). Scute length 1.26 (1.10–1.20), width 1.36 (1.28–1.50). EM length 0.26 (0.24–0.33), width 0.28 (0.24–0.32), height 0.24 (0.22–0.25). GO length 0.22 (0.20–0.25), width 0.24 (0.23–0.25). Leg II length 5.46 (3.90–4.78), LII/SL 4.33 (3.25–4.27). Ovipositor surface finely wrinkled, microspines absent or small and in imbricate arrangement, apical teeth absent, with 7 pairs curved apical setae with polyfurcate tips.

Sexual dimorphism.— The male has a TrIV spur.

Variation.— Ovipositor microspines are small to absent.

NATURAL HISTORY.— This species is known from dense forests. In mixed broadleaf evergreen forest (Arroyo Seco), it has been collected only beneath rocks in March and May. In the more mesic redwood forests (other localities), it was also found beneath decaying logs and in forest litter, and has been collected from February to June.

MATERIAL EXAMINED.— CALIFORNIA: **Monterey Co.:** Arroyo Seco Campground, under rocks, 22 March 1986 (T. Briggs, A. Jung, K. Hom, CAS), 1 juvenile; under granite in oak leaf litter, 13–15 May 1994 (D. Ubick, J. Boutin, CDU), 2 females; talus slope SW of Lakes, oak w maple, under granite, 6 May 1995 (D. Ubick, W. Savary, CAS, CDU), 8 males (including holotype, SEM), 13 females (including allotype, SEM); Kirk Creek at Nacimiento Road, el ca 1000', redwood forest, under rocks and in duff, 31 May 1991 (D. Ubick, CDU), 3 males, 4 females, 1 juvenile; Landels Hill Big Creek Reserve, 23 May 1987 (T. Briggs, W. Rauscher, A. Hui, CAS), 3 males, 6 females (SEM), 2 juveniles; Limekiln Creek, redwood forest, under limestone, 30–31 May 1991 (D. Ubick, CDU), 6 males, 10 females, 4 juveniles; redwood-bay litter, 31 May 1991 (D. Ubick, CDU), 4 males, 1 female; Limekiln Redwoods, nr Lucia, 3 February 1973 (T. Briggs, CAS), 5 females; N Fork Mill Creek at Nacimiento Road, el 1500–1600', redwood-tanoak duff, 1 June 1991 (D. Ubick, CDU), 2 males, 4 females; redwood forest, under rocks, 1 June 1991 (D. Ubick, CDU), 5 males, 7 females, 2 juveniles; maple litter, 1 June 1991 (D. Ubick, CDU), 1 male, 1 female. All specimens paratypes, unless indicated otherwise.

DISTRIBUTION.— Known only from Monterey County, California.

***Sitalcina chalone* Briggs, 1968, status nov.**

Figures 13e–f, 21–22.

Sitalcina flava chalone Briggs, 1968:15. Ubick and Briggs, 2002:437. Kury, 2003:220.

TYPE MATERIAL.— Male holotype and female allotype collected from under rhyolite in dense chaparral at N-facing slope of Bear Gulch Canyon, Pinnacles National Monument, San Benito County, California, on 26 November 1966, by T. Briggs, deposited at CAS, examined.

DIAGNOSIS.— This species differs from others in the group by its distinctive male genitalia: the short trough-like parastylar lobes and bifurcate stylus. The female ovipositor cuticle is only weakly imbricate, unlike most *Sitalcina*, but similar to *S. seca* and *S. sura*.

NOTE ON STATUS.— *S. chalone* is here regarded as a full species as it differs from *S. flava* in both somatic and genitalic characters. In *S. chalone*, the eyemound is longer and more conical than in *S. flava* and the parastylar lobes of the male genitalia are apically entire, lacking the sickle-shaped lobe of *S. flava*.

DESCRIPTION.— Body length 1.64–1.90, LII/SL 3.06–3.87 (N = 6). Color orange, appendages lighter. Body finely rugose, with larger tubercles along tergal margins, on scute posterior, and on eyemound; scute with 3 to 5 pairs of AT. EM conical, eyes present. GO apically rounded. Palpal femur with median dorsobasal row of 3 tubercles and 1 large mesal tubercle. Palpal megaspines: trochanter 2 small; femur 3 ventrobasal, 1 mesodistal (and 1 setose tubercle); patella 2 mesal, 1 ectal; tibia 2 mesal (and 1 setose tubercle), 2 ectal; tarsus 2 mesal, 2 ectal. TC, 3-5-5-5.

Male holotype (additional specimens, N = 2): Body length 1.64 (1.70–1.78). Scute length 1.08 (1.14–1.18), width 1.18 (1.24–1.28). EM length 0.26 (0.28), width 0.30 (0.30), height 0.24 (0.26–0.28). GO length 0.22 (0.24), width 0.22 (0.22). Leg II length 4.18 (3.92–4.28), LII/SL 3.87 (3.44–3.63). TrIV spur present, short stout and curved. Penis VP entire with about 18 pairs of lateral setae, AS absent; glans with rectangular DL, PSL short and broad; S straight and tubular with subapical prong.

Female allotype (additional specimens, N = 2): Body length 1.90 (1.76–1.82). Scute length 1.28 (1.10–1.15), width 1.30 (1.16–1.20). EM length 0.26 (0.24–0.26), width 0.30 (0.25–0.26), height 0.24 (0.22–0.24). GO length 0.20 (0.22–0.24), width 0.24 (0.24–0.25). Leg II length 3.92 (3.78–4.04), LII/SL 3.06 (3.44–3.51). Ovipositor surface with microspines in imbricate pattern, apical teeth absent, with 7 pairs of apical setae, curved, polyfurcate.

Sexual dimorphism.— The male has a TrIV spur.

NATURAL HISTORY.— Specimens have been collected from beneath volcanic rocks in broadleaf evergreen and chaparral forests, from November to May.

MATERIAL EXAMINED.— CALIFORNIA: **San Benito Co.**: Pinnacles National Monument, N facing slope of Bear Gulch Canyon, dense chaparral, under rhyolite, 26 November 1966 (T. Briggs, CAS), 2 male (including holotype), 3 females (including allotype); Bear Gulch Trail at Chalone Creek, under talus in oak-buckeye litter, 3 May 1992 (T. Briggs, D. Ubick, W. Rauscher, CAS), 8 males (SEM), 3 females (SEM), 2 juveniles; 0.5 mi E Chalone Campground, chaparral, under volcanic rocks, 20 March 1967 (J. Tom, CAS), 1 male, 1 female; Old Pinnacles Campground, moist chaparral slope, under rocks, 19 March 1967 (J. Tom, CAS), 3 males, 4 females.

DISTRIBUTION.— Known only from Pinnacles National Monument, San Benito County, California.

Sitalcina species

NOTE.— The following material clearly represents a new species, but as the available specimens were badly damaged, a description was not possible. However, the record is nonetheless noteworthy as it bridges the northern and southern elements of the *sura* group.

MATERIAL EXAMINED.— CALIFORNIA: **Santa Barbara Co.:** Montecito, E Mountain Drive, 0.9 OD mi from San Ysidro Road junction, undersurface of rock in closed canopy oak forest, 23 June 2003 (D. Palmer, J. Starrett, CAS), 1 male, 2 females; 4 June 2005 (J. Starrett, CAS), 1 male.

Sitalcina flava Briggs, 1968

Figures 13g–i, 23–24.

Sitalcina flava flava Briggs, 1968:15. Kury, 2003:220.

TYPE MATERIAL.— Male holotype and female allotype from under sandstone rocks in dense live oak forest at 1 mile S of Topanga Beach, Los Angeles County, California, collected on 24 March 1967, by T. Briggs and K. Hom, deposited at CAS, examined.

DIAGNOSIS.— This species differs from others in the group by its distinctive male genitalia, with the parastylar lobes apically divided and with the ventral branch sickle-shaped. The female ovipositor cuticle is strongly imbricate.

DESCRIPTION.— Body length 1.42–1.70, LII/SL 2.88–3.28 ($N = 4$). Color orange, appendages lighter. Body finely rugose, with larger tubercles along tergal margins and eyemound; scute with 2–3 pairs of AT. EM low, rounded, eyes present. GO rounded, triangular. Palpal femur with median dorsobasal row of 4 tubercles and 1 mesal tubercle. Palpal megaspines: trochanter 2 tubercles; femur 3 ventrobasal (and 1 tubercle), 1 mesodistal (and 1 tubercle); patella 2 mesal, 1 ectal (small); tibia 2 mesal (and 1 tubercle), 2 ectal (and 1 tubercle); tarsus 2 mesal, 2 ectal. TC, 3-5-5-5.

Male, holotype (paratype): Body length 1.70 (1.60). Scute length 1.08 (1.02), width 1.12 (1.06). EM length 0.28 (0.24), width 0.28 (0.26), height 0.18 (0.16). GO length 0.18 (0.16), width 0.18 (0.16). Leg II length 3.54 (2.94), LII/SL 3.28 (2.88). TrIV spur present, short stout and curved. Penis VP entire with about 11 pairs of lateral setae, AS absent; glans with DL distolaterally produced, PSL long, with sickle-shaped ventroapical lobe; S short and straight, enclosed by PSL.

Female, allotype (paratype): Body length 1.56 (1.42). Scute length 1.02 (1.02), width 1.10 (1.08). EM length 0.24 (0.22), width 0.24 (0.22), height 0.16 (0.14). GO length 0.16 (0.16), width 0.18 (0.18). Leg II (missing in allotype) length ? (2.98), LII/SL ? (2.92). Ovipositor surface with distinctly imbricate microspines, apical teeth absent, setae 6 pairs apical, 1 pair ventral subapical, curved, polyfurcate.

Sexual dimorphism.— The male has a TrIV spur.

Variation.— A female paratype is missing a retina.

NATURAL HISTORY.— Specimens have been collected from beneath sandstone rocks in dense oak and oak-sycamore forests, from December to April.

MATERIAL EXAMINED.— CALIFORNIA: **Los Angeles Co.:** Santa Monica Mountains, Sepulveda Canyon, 1 July 1958 (V. Roth, AMNH), 1 male; Topanga Canyon, 1 mi S Topanga, dense live oak forest, under sandstone, 24 March 1967 (T. Briggs, K. Hom, CAS), male holotype, female allotype, and 1 male and 2 female paratypes; 3.3 mi N Topanga Beach, dense live oak forest, under sandstone, 7 April 1966 (T. Briggs, K. Hom, V. Lee, CAS), 6 males (1 SEM), 2 females (1 SEM); 4.7 mi N Topanga, in oak-sycamore litter, 27 December 1966 (T. Briggs, CAS), 1 female.

DISTRIBUTION.— Known only from the Santa Monica Mountains, Los Angeles County, California.

Sitalcina borregoensis Briggs, 1968

Fig. 25.

Sitalcina borregoensis Briggs, 1968:30. Kury, 2003:220.

TYPE MATERIAL.— Female holotype from Mountain Palm Spring, Anza-Borrego State Park, collected on 5 April 1967, by T. Briggs, deposited at CAS, examined.

DIAGNOSIS.— This species, known only from the female, differs from others in the group by the extremely low eyemound. The ovipositor cuticle appears to be only moderately imbricate.

DESCRIPTION.— Body length 1.26–1.40, LII/SL 2.96–3.20 (N = 2). Color orange-brown, appendages lighter. Body finely rugose, few larger tubercles along tergal margins, 1 pair anteriorly on eyemound; scute with 3 pairs of AT. EM low, flattened, eyes present. Palpal femur with median dorsobasal row of 4 tubercles and 1 small mesal tubercle. Palpal megaspines: trochanter 1 ventral, small; femur 3 ventrobasal, 1 mesodistal; patella 2 mesal, 1 ectal; tibia 2 mesal, 2 ectal; tarsus 2 mesal, 2 ectal. TC, 3-5-5-5.

Male, unknown.

Female holotype (paratype): Body length 1.26 (1.40). Scute length 0.90 (0.90), width 0.92 (0.88). EM length 0.18 (0.20), width 0.20 (0.22), height 0.14 (0.16). GO length 0.16 (0.16), width 0.18 (0.18). Leg II length 2.66 (2.88), LII/SL 2.96 (3.20). GO subtriangular. Ovipositor surface with microspines arranged in moderately imbricate pattern, apical teeth absent, 7 pairs apical setae, curved, polyfurcate.

NATURAL HISTORY.— Specimens were collected from beneath granite boulders in a palm canyon oasis.

MATERIAL EXAMINED.— CALIFORNIA: **San Diego Co.**: Anza-Borrego State Park, Mountain Palm Spring, 5 April 1967 (T. Briggs, CAS), 3 females (including holotype).

DISTRIBUTION.— Known only from the type locality.

Arizona species

The following three species seem to be most closely related, based on similarity in the male genitalia. The penis of *S. rothi* (Figs. 13j, 26a–c) could only be examined through a compound microscope and has the general form to the other two, although it was not possible to see much detail. The penes in both *S. peacheyi* (Figs. 13k–m, 26f–g, 29–30) and *S. catalina* (Figs. 26d–e, 27–28) are similar in having a glans with bilobed and interlocking PSL lobes, a ventrobasal structure probably representing the stylar base, and a short, straight S that lies on the dorsal surface between the PSL and DL. These two species do differ in some details: the ventral lobe of the PSL is distinctly toothed in *S. peacheyi* (Figs. 30c–f), but not in *S. catalina* (Figs. 28c–d); and the DL is medially notched in *S. catalina* (Fig. 28d), but not in *S. peacheyi* (Fig. 30f). The three species also differ in somatic characters, with differences in the eyemound size and tuberculation and in the form of the male TrIV, which are detailed in the species' diagnoses.

Sitalcina peacheyi Ubick and Briggs, sp. nov.

Figures 13k–m, 26f–g, 29–30.

TYPE MATERIAL.— Male holotype from beneath rocks in Cave of the Bells, Gardner Canyon, Santa Rita Mountains, Santa Cruz County, Arizona, collected on 28 June 1988 by D. Ubick, T. Briggs, B. Peachey, W. Savary, and W. Rauscher, deposited at CAS.

ETYMOLOGY.— This species is named after Bill Peachey, whose knowledge of Arizona caves and hospitality made our visit to the type locality possible.

DIAGNOSIS.— This species is most readily distinguished from others in Arizona by somatic characters: eyemound medium-sized with few pointed tubercles (Figs. 29a–b), and male TrIV spur broadly rounded and recumbent (Figs. 26f–g).

DESCRIPTION.— Body length 1.36–1.90, LII/SL 2.90–4.30 (N = 9). Color pale yellow to orange, appendages lighter. Body finely rugose, with few larger tubercles along tergal margins and at eyemound; scute with 3–4 pairs of AT. EM rounded, eyes present. GO rounded, subtriangular. Palpal femur with median dorsobasal row of 3–4 tubercles and 1 moderately sized mesal tubercle. Palpal megaspines: trochanter 2, small; femur 3 ventrobasal, 2 mesodistal; patella 2 mesal, 1 ectal; tibia 2 mesal, 2 ectal; tarsus 2 mesal, 2 ectal. TC, 3-5-5-5.

Male, holotype (paratypes, N = 4): Body length 1.90 (1.36–1.65). Scute length 1.15 (1.03–1.16), width 1.10 (1.00–1.66). EM length 0.30 (0.23–0.30), width 0.30 (0.22–0.32), height 0.20 (0.17–0.24). GO length 0.16 (0.14–0.18), width 0.18 (0.16–0.18). Leg II length 4.24 (3.14–4.45), LII/SL 3.70 (3.00–4.30). TrIV spur present, short, broad, curved. Penis VP entire, apically rounded, with 10 pairs of setae, AS absent; glans with DL quadrate, PSL apically bilobed with interlocking dorsal branch and ventral lobe with apical serrations; S straight, tubular.

Female allotype (paratypes, N = 3): Body length 1.53 (1.44–1.64). Scute length 1.02 (1.02–1.08), width 1.10 (1.04–1.10). EM length 0.25 (0.22–0.26), width 0.25 (0.22–0.24), height 0.15 (0.15–0.24). GO length 0.18 (0.15–0.16), width 0.21 (0.18–0.20). Leg II length 3.27 (2.95–4.02), LII/SL 3.20 (2.90–3.70). Ovipositor surface strongly imbricate with microspines, apical teeth absent, with 7 pairs of curved apical setae, polyfurcate.

Sexual dimorphism.— The male has a TrIV spur.

Variation.— Individuals from caves are paler in color and have relatively longer legs: LII/SL (caves) = 3.10–4.30 (3 males) and 3.20–3.70 (2 females); LII/SL (epigeal) = 3.00–3.10 (2 males) and 2.90–3.04 (2 females). The size of the TrIV spur varies, being largest in specimens from the Baboquivari Mountains.

NATURAL HISTORY.— Most specimens have been collected from caves, others are from beneath rocks and in leaf litter.

MATERIAL EXAMINED.— ARIZONA: **Pima Co.:** Baboquivari Mountains, Brown Canyon, 19 July 1959 (V. Roth, AMNH), 3 males, 2 females; Colossal Cave County Park, Arkenstone Cave, ex register room under rocks, 11 August 1990 (B. Pape, CAS), 2 males; Colossal Cave Mountain Park, Bearpaw Cave, 23 September 1994 (B. Pape, CAS), 1 female; Madera Canyon, Madera Picnic Grounds, under rocks in duff, 30 April 1972 (W. Icenogle, CAS), 2 males, 6 females; Madera Canyon, Santa Rita Mountains, 27 July 1949 (W. Gertsch, CJC), 1 male. **Santa Cruz Co.:** Santa Rita Mountains, Cave Creek Canyon, N31°42'55.8", W110°45'46.1", oak-juniper-pine forest, under rocks, 2 August 1996 (D. Ubick, P. Craig, CDU), 2 males, 1 female, 1 juvenile; Santa Rita Mountains, Gardner Canyon, Cave of the Bells, el 5300', 24 June 1988 (D. Ubick, T. Briggs, B. Peachey, W. Rauscher, W. Savary, CDU, CAS), 5 males (including holotype), 6 females (including allotype, SEM), 2 juveniles; same as above but Hilton's Hole Cave, 5 males (SEM), 5 females; same as above but Onyx Cave, 1 male, 5 females; Hidden Cave, 6 mi WNW Sonoita, 21 March 1992 (B. Pape, CAS), 1 male, 2 females. All specimens paratypes, unless indicated otherwise.

DISTRIBUTION.— Known from Santa Cruz and southern Pima counties, Arizona.

Sitalcina catalina Ubick and Briggs, sp. nov.

Figures 26d–e, 27–28.

TYPE MATERIAL.— Male holotype and female allotype from beneath fallen bark at 30 mi NE Tucson, Santa Catalina Mountains, el 8000', Pima County, Arizona, on 17 August 1968, by T. Briggs, K. Hom, A. Jung, D. Owyang, and J. Tom, deposited at CAS.

ETYMOLOGY.— The species name refers to the known distribution, Santa Catalina Mountains.

DIAGNOSIS.— This species is most readily distinguished from others in Arizona by somatic characters: eyemound large, with several pointed tubercles (Figs. 27a–b), and male TrIV spur short, narrow and projecting (Figs. 26d–e).

DESCRIPTION.— Body length 1.25–1.72; LII/SL 3.11–4.51 (N = 7). Color yellowish-orange, appendages lighter. Body finely rugose, with few larger tubercles along tergal margins and several at eyemound; scute with 2–3 pairs of AT. EM rounded, eyes present. GO apically rounded. Palpal femur with median dorsobasal row of 3–4 tubercles and 1 moderately sized mesal tubercle. Palpal megaspines: trochanter none; femur 3 ventrobasal, 2 mesodistal (distalmost small); patella 2 mesal, 1 ectal; tibia 2 mesal, 2 ectal; tarsus 2 mesal, 2 ectal. TC, 3-5-5-5.

Male, holotype (paratypes, N = 3): Body length 1.70 (1.25–1.61). Scute length 1.15 (1.04–1.15), width 1.16 (1.03–1.20). EM length 0.25 (0.23–0.25), width 0.26 (0.25–0.28), height 0.18 (0.13–0.17). GO length 0.14 (0.14–0.16), width 0.18 (0.17–0.19). Leg II length 3.58 (3.54–5.00), LII/SL 3.11 (3.40–4.35). TrIV spur present, slender, projecting from Tr. Penis VP entire, apically rounded, with 8 pairs of setae, AS absent; glans with quadrate DL, apically notched, PSL apically bilobed with interlocking dorsal branch, ventral lobe lacking apical serrations; S straight, tubular.

Female allotype (paratypes, N = 2): Body length 1.72 (1.50–1.53). Scute length 1.20 (1.00–1.15), width 1.15 (1.10). EM length 0.22 (0.22–0.23), width 0.26 (0.24–0.26), height 0.15 (0.15–0.16). GO length 0.18 (0.15–0.16), width 0.25 (0.22). Leg II length 3.92 (3.62–4.51), LII/SL 3.27 (3.15–4.51). Ovipositor surface strongly imbricate with microspines, apical teeth absent, with 7 pairs of curved apical setae, polyfurcate.

Sexual dimorphism.— The male has a TrIV spur.

Variation.— Individuals from caves have slightly longer legs: LII/SL (caves) = 4.25–4.35 (2 males) and 4.51 (female); LII/SL (epigean) = 3.11–3.40 (2 males) and 3.15–3.27 (2 females). The cavernicolous males have a TrIV spur both broader and longer than in surface populations.

NATURAL HISTORY.— Two of the three collections are from caves. The epigean sample is from beneath accumulated layers of fallen coniferous bark.

MATERIAL EXAMINED.— ARIZONA: **Pima Co.:** Santa Catalina Mountains, Water Cave, January 1969 (K. Stephen, CWS), 2 males; 30 mi NE Tucson, el 8000', under bark, 17 August 1968 (T. Briggs, K. Hom, D. Owyang, J. Tom, CAS), 6 males (including holotype, SEM), 11 females (including allotype, SEM), 1 juvenile. **Pinal Co.:** Santa Catalina Mountains, Nugget Cave, 21 August 1993 (R. Pape, CAS), 2 males, 1 female, 1 juvenile. All specimens paratypes, unless indicated otherwise.

DISTRIBUTION.— Known from the Santa Catalina Mountains in Pinal and northern Pima counties, Arizona.

***Sitalcina rothi* Ubick and Briggs, sp. nov.**

Figures 13j, 26a–c.

TYPE MATERIAL.— Male holotype from Yarnell, Yavapai County, Arizona, collected by V. Roth on 3 September 1961, deposited in AMNH.

ETYMOLOGY.— This species is named in honor of the late Vince Roth, collector of this and many other interesting phalangodids.

DIAGNOSIS.— This species differs from other *Sitalcina* by its very low eyemound that lacks pointed tubercles (Fig. 26a) and the form of the male TrIV spur: long, straight and projecting (Figs. 26b–c).

DESCRIPTION.— Body length 1.50–1.56, LII/SL 2.98–3.08 (N = 2). Color yellowish-orange, appendages yellow. Body finely rugose, with few larger tubercles, mostly along tergal margins;

scute with 2–3 pairs of AT. EM low, flattened, eyes present. Palpal femur with median dorsobasal row of 3 small tubercles and 1 small mesal tubercle. Palpal megaspines: trochanter none; femur 3 ventrobasal, 1 mesodistal; patella 2 mesal, 1 ectal; tibia and tarsus 2 mesal, 2 ectal. TC, 3-5-5-5.

Male (holotype): Body length 1.50. Scute length 0.98, width 1.00. EM length 0.24, width 0.24, height 0.10. GO length 0.14, width 0.18. Leg II length 3.02, LII/SL 3.08. TrIV spur present, short, straight. GO oval, longer than wide. Penis with VP entire, bearing about 6 pairs of setae, AS absent; glans with quadrate DL, PSL trough-like; S not visible.

Female (allotype): Body length 1.56. Scute length 0.94, width 1.04. EM length 0.23, width 0.24, height 0.10. GO length 0.12, width 0.18. Leg II length 2.80, LII/SL 2.98. GO oval. Ovipositor not expanded.

Sexual dimorphism.— The male has a TrIV spur.

NATURAL HISTORY.— Unknown.

MATERIAL EXAMINED.— ARIZONA: Yavapai Co.: Yamell, 3 September 1961 (V. Roth, AMNH), male holotype, female allotype.

DISTRIBUTION.— Known only from the type locality.

Sitalcina lobata Group

DIAGNOSIS.— The single species representing this group differs from other sitalcinoids in having a dorsal row of setose tubercles on the palpal femur (Figs. 31c–e), unlike those in the *sura* group which are asetose (Figs. 21b–c), but superficially resembling those in *Banksula*, of the bifurcate clade (Figs. 5b–c). The male is unique in phalangodids in having the trochanter IV elongated and bearing two spurs, one strongly curved (Figs. 31f–g). The male genitalia have the unique combination of threadlike stylus, trilobed parastylar lobes, and long ventral plate setae (Figs. 32a–f). The female resembles that of *S. californica* in having pointed ovipositor setae (Figs. 32g–h), rather than polyfurcate as in the *sura* group (Figs. 20f, j).

INCLUDED SPECIES.— Only *S. lobata* Goodnight and Goodnight.

DISTRIBUTION.— Southern California.

Sitalcina lobata Goodnight and Goodnight, 1942

Figures 2f, 3f, 14d–f, 31–32.

Sitalcina lobatus Goodnight and Goodnight, 1942:9. Briggs and Hom, 1966:263. Briggs, 1968:12.

Sitalcina lobata, Kury, 2003:220.

TYPE MATERIAL.—Female holotype from Oceanside, California, collected on 11 July 1931, [collector unknown], deposited at AMNH, examined.

DIAGNOSIS.— Same as for species group.

DESCRIPTION.— Body length 1.38–2.02, LII/SL 2.73–3.80 (N = 13). Color brownish-orange, appendages paler. Body coarsely rugose, with numerous larger tubercles along tergal margins, in transverse rows across scute, and on and surrounding eyemound. Scute with 3–5 pairs of AT. EM rounded, eyes present. Palpal femur with median dorsobasal row of 5–6 small tubercles, each bearing a seta, lacking mesal tubercle. Palpal megaspines: trochanter 0 (but with 2 setose tubercles); femur 3 ventrobasal (and large tubercle), 1 mesodistal (and 1 apical seta); patella 2 mesal, 1 ectal; tibia 2 mesal (and 1 apical seta), 2 ectal (and 1 basal seta); tarsus 2 mesal, 2 ectal. TC, 3-5-5-5.

Male (N = 6): Body length 1.50–1.84. Scute length 1.02–1.28, width 1.24–1.44. EM length 0.24–0.28, width 0.25–0.27, height 0.15–0.20. GO length 0.17–0.21, width 0.23–0.25. Leg II length 3.10–4.26, LII/SL 2.96–3.44. TrIV greatly elongated, with 2 distoventral spurs, ectal large, tapering, strongly curved. GO rounded, trapezoidal. Penis VP entire with rounded extension pro-

jecting beyond setae, with 12 pairs of long setae, AS absent; glans with DL quadrate, PSL broad, apically trilobed; S long, slender, curved.

Female holotype (additional specimens, $N = 6$): Body length 1.78 (1.38–2.02). Scute length 1.14 (1.04–1.26), width 1.30 (1.12–1.50). EM length 0.25 (0.20–0.27), width 0.24 (0.20–0.27), height 0.17 (0.13–0.19). GO length 0.15 (0.14–0.18), width 0.18 (0.18–0.21). Leg II length 3.12 (3.02–4.24), LII/SL 2.73 (2.73–3.80). GO rounded hemispherical. Ovipositor surface with microspines in imbricate arrangement, apical teeth absent, with 6 pairs apical setae, hooked, pointed.

Sexual dimorphism.—The male has a greatly elongated TrIV with 2 distoventral spurs and a larger GO than in the female.

Variation.—The male TrIV varies greatly in size, equaling femur length in some specimens, to about half that size in others. Of the 18 specimens measured, most have the TrL/FmL from 0.6 to 1.0, but in the single specimen from Whitewater Canyon, it is distinctly shorter (TrL/FmL = 0.4). Although this specimen seems to be conspecific in other features, additional material from this locality would be necessary to confirm its placement. In most specimens the ectal TrIV spur is usually evenly curved, but is angular in some.

Juveniles.—A penultimate male (from San Timoteo) has an elongate TrIV, which falls into the range of variation of adults. The ectal spur is a stout projection, rather than the tapering loop found in adults.

NATURAL HISTORY.—Most specimens have been collected in oak forests, with records also from chaparral, pine, and sycamore, from beneath rocks and in leaf litter. Specimens are also from woodrat (*Neotoma*) nests and tarantula (*Aphonopelma*) burrows. Most collections are from December to May, with one female in July. A large series collected in August is from tarantula burrows.

MATERIAL EXAMINED.—CALIFORNIA: **Los Angeles Co.:** 7 mi N Claremont on road to Mount Baldy, under logs and rocks in deep canyon, 31 December 1966 (T. Briggs, K. Hom, A. Jung, CAS), 2 males, 4 females. **Orange Co.:** NE Laguna Beach, San Joaquin Hills on ridge E of Emerald Canyon, N33.57091°, W117.78193°, el. 489m, live pitfall in chaparral, 22 May 2003 (D. Hogan, CAS), 1 female; 3 mi W San Juan, Cleveland National Forest, sycamore litter, 2 March 1958 (I. Newell, AMNH), 1 female. **Riverside Co.:** 3 mi W Beaumont, oak litter, 3 November 1957 (I. Newell, AMNH), 1 male, 1 female; same but 15 February 1959, 1 female; Box Springs Grade, nr Riverside, under stones on desert hillside, 26 November–1 December 1925 (J. Chamberlin, AMNH), 3 males, 4 females; Hurkey Creek Campground, San Bernardino National Forest, under rocks and in pine litter, 3 April 1966 (T. Briggs, K. Hom, CAS), 3 males, 2 females; 1 mi W Lake Elsinore, Slater Canyon, under wood, 21 December 1966 (T. Briggs, CAS), 1 male; 2 mi NW Perris, chaparral, under granite, 24 March 1967 (V. Lee, CAS), 2 males (SEM); 2.5 mi N Sage, 10 November 1957 (I. Newell, AMNH), 1 female; 9.5 mi N San Jacinto on Hwy 79, under rocks, 3 April 1966 (V. Lee, K. Hom, CAS), 1 male, 2 females; San Timoteo Canyon, ex *Neotoma* nest, 24 April 1952 (R. Ryckman et al, AMNH), 1 penultimate male; 18 May 1952, 1 female; Whitewater Canyon, *Neotoma* nest, 27 December 1979 (no collector, UCR), 1 male; Winchester, under rock, 19 January 1971 (J. Rowland, CAS), 1 male, 1 female; 1 mi NW Winchester, in tarantula burrow, 19 August 1967 (W. Icenogle, CAS), 2 males, 2 females; 20 August 1967, 2 males (SEM), 18 females, (SEM). **San Bernardino Co.:** San Bernardino Mtns., Hwy 18, 2 mi E junction Hwy 138, N34°13'23", W117°16'07", el. 4411 ft, oak duff, 14 December 2002 (R. Vetter, CAS), 1 male. **San Diego Co.:** Oceanside, 11 July 1931 (no collector, AMNH), 1 female (holotype); 5.9 mi N Lakeside, under rocks in oak leaves, 28 December 1966 (T. Briggs, K. Hom, CAS), 2 males, 4 females (SEM); Mt. Palomar, below Henshaw Dam, 25 July 1931 (W. Ivie, AMNH), 1 female; 7 mi E Rincon Spring, oak forest, under granite, 28 March 1970 (T. Briggs, CAS), 2 females.

DISTRIBUTION.—Los Angeles to San Diego counties, California.

Genus *Enigmina* Ubick and Briggs, gen. nov.TYPE SPECIES: *Sitalcina granita* Briggs, 1968

DIAGNOSIS.— This genus differs from all other sitalcinoids by the combination of the following characters: eyes present (Fig. 33b), palpal femur lacking dorsal and mesal tubercles (Fig. 35d), ovipositor lacking microspines (Fig. 34h), male with 2 short ventral spurs on trochanter IV (Fig. 33e) and penis with stout stylus, large dorsal lobe, and separate parastylar lobes (Figs. 14g–h).

DESCRIPTION — Body length 1.56–2.20. Dorsum finely rugose, with rows of larger tubercles along posterior tergal margins; scute with 1 pair of small AT. EM rounded, conical or cylindrical, with eyes. Cheliceral base with abrupt dorsodistal swelling. Palpal megaspines: femur 3 ventrobasal, 1–2 mesodistal; patella 1 ectal, 2 mesal; tibia 2–3 ectal, 2–3 mesal; tarsus 2 ectal, 2 mesal. TC, 3-5-5-5

Male: Penis with VP entire, bearing 8 pairs of setae; glans only unfolds during expansion, with large DL, posteriorly rounded, apically flattened, with PSL not fused, broadly rounded; S short, stout.

Female: Ovipositor cuticle lacking microspines, lacking apical teeth, with 8 pairs apical setae.

Sexual dimorphism: The TrIV has a pair of short spurs in males and a single small tubercle in females.

INCLUDED SPECIES.— *E. granita* (Briggs), *E. warrenorum* sp. nov.

DISTRIBUTION.— Southern Sierra Nevada, California.

***Enigmina granita* (Briggs, 1968)**

Figs. 2g, 3g, 33–34.

Sitalcina granita Briggs, 1968:14. Kury, 2003:220.

TYPE MATERIAL.— The male holotype, female allotype, and 10 paratypes (4 males, 6 females), collected under granite in an oak grassland, 7 mi E Fountain Springs, Tulare County, California, on 14 March 1967, by T. Briggs, V. Lee, A. Jung, and K. Hom, deposited at CAS, examined.

DIAGNOSIS.— This species differs from *E. warrenorum* in having an eyemound that is both smaller and lacking apical tubercles, a more coarsely tuberculate scute, only 2 pairs of megaspines on the palpal tibia, shorter and subequal processes on the male trochanter IV (mesal prong larger in *E. warrenorum*), and an ovipositor with apical setae curved and (at least in some specimens) polyfurcate (hooked and pointed in *E. warrenorum*). Only minor differences were noted in the male genitalia: parastylar lobe surface less densely toothed in *E. granita*.

DESCRIPTION.— Body length 1.56–2.18, LII/SL 2.84–3.46 (N = 14). Color yellowish-orange, appendages lighter. Body finely rugose, with larger tubercles along tergal margins; scute with 1 pair of AT. EM conical, lacking sharp tubercles, eyes present. GO apically rounded. Palpal femur with dorsal row of a few setae, lacking mesal or dorsal tubercles. Palpal megaspines: trochanter 1 short; femur 3 ventrobasal, 1 mesodistal (and apical seta); patella 2 mesal (apical small), 1 ectal; tibia 2 mesal (with basal seta), 2 ectal (with basal tubercle); tarsus 2 mesal, 2 ectal. TC, 3-5-5-5.

Male, holotype (additional specimens, N = 6): Body length 1.84 (1.56–2.18). Scute length 1.26 (1.00–1.46), width 1.20 (0.98–1.44). EM length 0.30 (0.24–0.44), width 0.32 (0.26–0.42), height 0.28 (0.20–0.36). GO length 0.22 (0.16–0.20), width 0.14 (0.14–0.18). Leg II length 3.80 (3.40–4.16), LII/SL 3.17 (2.85–3.42). TrIV with 2 spurs, short, subequal. Penis VP entire, with 8 pairs of lateral setae (of which 2 pairs are along the lateral VP margin), AS absent; glans with DL posteriorly rounded, apically flattened, PSL broadly rounded; S short, stout.

Female, allotype (additional specimens, N = 6): Body length 1.72 (1.68–1.96). Scute length

1.18 (1.00–1.22), width 1.14 (1.14–1.34). EM length 0.26 (0.26), width 0.26 (0.28–0.30), height 0.24 (0.18–0.30). GO length 0.16 (0.15–0.17), width 0.18 (0.18–0.20). Leg II length 3.40 (3.30–3.82), LII/SL 2.88 (2.84–3.46). TrIV with tiny ventroapical tubercle. Ovipositor surface finely wrinkled, lacking microspines, apical teeth absent, with 7 pairs of apical setae, curved, with polyfurcate tips.

Sexual dimorphism.—The male has 2 short TrIV spurs.

Variation.—Individuals vary in body size, even at a single locality; both small and large individuals of both sexes were collected on a single visit to Bonsall Hill. Larger males have a slightly larger and more apically projecting EM. Although leg length varies directly to body size in the specimens measured, LII/SL appears to vary inversely to body size, especially in males. The two smallest males (SL = 1.0) have the highest LII/SL (≥ 4.0), and the two largest (SL ≥ 1.4) have the lowest LII/SL (≤ 3.0). This difference in relative leg length is unexpected and needs closer examination.

NATURAL HISTORY.—Specimens were collected beneath granite boulders in oak forests.

MATERIAL EXAMINED.—CALIFORNIA: **Tulare Co.:** Hungry Hollow, 5.8 mi SE Avenue 264 on Avenue 120, oak woodland, under granite, 28 March 1991 (D. Ubick, T. Briggs, W. Rauscher, CAS), 1 female; Rd 296, 0.3 mi N Deer Creek Rd, N35°5.9'46.0", W118°54'38.4", oak grassland, under granite, 18 January 2004 (D. Ubick, T. Briggs, CAS), 6 males, 3 females; N slope Bonsall Hill, 1 mi W Mtn. Rd. 160 on Mtn. Rd. 137, under granite in oak-buckeye gully, 28 March 1991 (D. Ubick, T. Briggs, W. Rauscher, CAS, CDU), 6 males, 3 females, 1 juvenile; 6.3 mi E Fountain Springs, oak grassland, under granite, 19 March 1967 (T. Briggs, K. Hom, A. Jung, P. Lum, CAS), 7 males, 7 females, 2 juveniles; 7 mi E Fountain Springs, oak grassland, under granite, 14 March 1967 (T. Briggs, V. Lee, A. Jung, and K. Hom, CAS), 5 males (including holotype), 7 females (including allotype). **Kern Co.:** 1.4 mi E Granite Station, under granite, 22 January 1967 (K. Hom, CAS), 1 male.

DISTRIBUTION.—Known from Tulare and Kern counties, California.

***Enigmima warrenorum* Ubick and Briggs, sp. nov.**

Figs. 14g–h, 35–36.

TYPE MATERIAL.—The female holotype and male allotype were collected under logs and in duff in a mixed coniferous forest, el 5200', 2.25 mi W Johnsondale, Tulare County, California, on 2 July 1988, by D. Ubick, T. Briggs, W. Rauscher, and W. Savary, deposited at CAS.

ETYMOLOGY.—This species is named in honor of Warren C. Rauscher and Warren E. Savary, not only for their help in collecting the type series, but for their continuing assistance in many areas.

DIAGNOSIS.—See *E. granita* (Briggs).

DESCRIPTION.—Body length 1.80–2.20 (N = 4), LII/SL 3.87–3.91 (N = 3). Color yellowish-orange, appendages lighter. Body finely rugose, with few larger tubercles along tergal margins and dorsally on eyemound; scute with 1 pair of AT. EM high, cylindrical, with sharp tubercles, eyes present. Palpal femur with dorsal row of a few setae, lacking mesal tubercle. Palpal megaspines: trochanter 1 short; femur 3 ventrobasal, 1 mesodistal (and apical seta); patella 2 mesal, 1 ectal; tibia 3 mesal, 3 ectal; tarsus 2 mesal, 2 ectal. TC, 3-5-5-5.

Male allotype (SEM): Body length 2.20 (1.84). Scute length 1.40 (1.44), width 1.20 (1.22). EM length 0.22 (0.22), width 0.32 (0.32), height 0.25 (0.25). GO length 0.22 (0.22), width 0.19 (0.19). Leg II missing. TrIV with 2 short spurs. GO apically rounded. Penis VP entire, with 8 pairs of lateral setae (of which 2 pairs are along the lateral VP margin), AS absent; glans with DL posteriorly rounded, apically flattened, PSL broadly rounded; S short, stout.

Female holotype (2 paratypes): Body length 1.80 (1.90–1.96). Scute length 1.26 (1.24–1.40), width 1.30 (1.30–1.44). EM length 0.25 (0.25–0.28), width 0.30 (0.30–0.32), height 0.22

(0.21–0.24). GO length 0.18 (0.17–0.18), width 0.22 (0.22). Leg II length 4.82 (4.80–5.48), LII/SL 3.38 (3.87–3.91). TrIV with small ventroapical tubercle. Genital operculum hemispherical, apically rounded. Ovipositor surface finely wrinkled, lacking microspines, apical teeth absent, with 7 pairs of hooked, pointed apical setae.

Juvenile: Body length 1.20, scute length 0.91, leg II length 4.04, LII/SL 4.44. Color white. Palpal megaspinules as in adult. TC, 1-1-2-2. TrIV with 2 small ventral tubercles, mesal larger (indicating that the specimen is a male).

Sexual dimorphism.—The male has a pair of short ventral spurs on the TrIV (a single small tubercle in the female), a slightly higher EM, and a relatively longer GO.

NATURAL HISTORY.—Specimens have been collected under logs and in duff in a coniferous forest.

MATERIAL EXAMINED.—CALIFORNIA: **Tulare Co.**: 2.25 mi W Johnsondale, el 5200', mixed coniferous forest, under logs and in duff, 2 July 1988 (D. Ubick, T. Briggs, W. Rauscher, W. Savary, CAS), female holotype, male allotype (SEM), 1 male paratype, 3 female paratypes (SEM), 1 juvenile.

DISTRIBUTION.—Known only from the type locality.

Genus *Tularina* Ubick and Briggs, gen. nov.

TYPE SPECIES: *Tularina tularensis* Ubick and Briggs, sp. nov.

DIAGNOSIS.—This genus differs from all other sitalcinoids, except *Microcinella* and *Microcina*, in lacking eyes and having a low eyemound (Figs. 38a–e). Males differ from these two genera in having modified parastylar lobes which are elongated and fused (Fig. 37); females in having ovipositor microspines arranged in linear series (Fig. 39j) or absent (Fig. 43g) (rather than being randomly distributed).

ETYMOLOGY.—The genus name is a contraction of Tulare County, the known distribution of the genus, and *Sitalcina* and is considered feminine in gender.

DESCRIPTION.—Body length 0.91–1.70. Dorsal sculpturing of fine tubercles, in random or areolate arrangement; scute lacking AT. EM broad and low, lacking eyes. Cheliceral base with abrupt dorsodistal swelling. Palpal trochanter with tuberculate dorsal swelling. Palpal megaspinules: femur 3 ventrobasal, 1 mesodistal; patella 1 mesal; tibia and tarsus each 2 ectal, 2 mesal. TC, 3-5-4-4 and 3-5-5-5.

Male: Penis VP entire, mesoapically elongated, bearing 8 to about 30 pairs of short to extremely long setae, lacking AS; glans only unfolds during expansion, DL absent or present, PSL elongate and fused, sometimes with apical notch; S straight to slightly curved, with or without subapical tubule.

Female: Ovipositor cuticle with small microspines arranged in transverse series, or smooth (*T. scopula*), with 7 pairs apical setae, apically hooked, with tips entire (*T. tularensis*) or bifurcate.

Sexual dimorphism: None observed in *T. plumosa* and *T. tularensis*. The male of *T. scopula* has a ventral tubercle on TrIV, absent in females.

INCLUDED SPECIES.—*T. plumosa* sp. nov., *T. scopula* (Briggs), *T. tularensis* sp. nov.

DISTRIBUTION.—Known only from the southern Sierran foothills, Tulare County, California.

***Tularina tularensis* Ubick and Briggs, sp. nov.**

Figs. 2c, 3c, 37a–d, 38–39.

TYPE MATERIAL.—Male holotype from beneath serpentine boulders in grassland on the W slope of Rocky Hill, just E of Exeter on Hwy. 130, Tulare County, California, collected on 26 January 1991 by D. Ubick and M. Moody, deposited at CAS.

ETYMOLOGY.—The specific name refers to the type locality.

DIAGNOSIS.— This species differs from others in the genus by its areolate abdominal dorsum, the relatively short setae on the male ventral plate, and the pointed apical setae on the female ovipositor.

DESCRIPTION.— Body length 0.91–1.14, LII/SL 2.95–3.22 ($N = 4$). Color yellowish-orange, appendages paler. Body covering of fine tubercles, in areolate arrangement on opisthosoma; scute lacking AT. EM low and quadrate, eyes absent (lacking both retina and cornea). GO rounded. Palpal megaspinules: trochanter 0; femur 3 ventrobasal, 1 mesodistal; patella 1 mesal, 1 ectal; tibia 2 mesal, 2 ectal; tarsus 2 mesal, 2 ectal. TC, 3-5-4-4.

Male, holotype (paratype): Body length 0.91 (0.92). Scute length 0.68 (0.69), width 0.65 (0.70). EM length 0.18 (0.19), width 0.19 (0.19), height 0.12 (0.12). GO length 0.10 (0.10), width 0.14 (0.14). Leg II length 2.10 (2.22), LII/SL 3.09 (3.22). TrIV spur absent. Penis VP entire with rounded apical extension, with 7–8 pairs of setae (2 pairs along lateral margin of VP), AS absent; glans divided distally into dorsal and ventral lobes, narrow, pointed, subequal in size; S short, straight, enclosed by lobes.

Female, allotype (paratype): Body length 1.06 (1.14). Scute length 0.74 (0.74), width 0.79 (0.76). EM length 0.19 (0.18), width 0.18 (0.18), height 0.12 (0.12). GO length 0.12 (0.12), width 0.16 (0.14). Leg II length 2.18 (2.26), LII/SL 2.95 (3.05). Ovipositor surface with short microspines, arranged in short transverse series, apical teeth absent, 6 pairs of setae (arranged in 4 triads) and 1 dorsal subapical pair; apical setae strongly hooked, tips pointed.

Sexual dimorphism.— None observed.

NATURAL HISTORY.— All specimens have been collected beneath serpentine boulders in grassland biomes, in January and March.

MATERIAL EXAMINED.— CALIFORNIA: **Tulare Co.**: W slope of Rocky Hill, just E of Exeter on Hwy 130, grassland, under serpentine, 26 January 1991 (D. Ubick, M. Moody, CAS, CDU), male holotype, female allotype and 1 male; 28 March 1991 (D. Ubick, T. S. Briggs, W. Rauscher, CAS, CDU), 1 male, 1 female; 17 January 2004 (D. Ubick, T. Briggs, CAS, CDU), 6 males (SEM), 4 females (SEM); N access to Rocky Hill, 17 January 2004 (D. Ubick, T. Briggs, CAS, CDU), 1 male, 2 females. All specimens paratypes, unless indicated otherwise.

DISTRIBUTION.— Known only from the type locality.

***Tularina plumosa* Ubick and Briggs, sp. nov.**

Figs. 37e–h, 40–41.

TYPE MATERIAL.— Male holotype collected from beneath granite rock in grassland, on Bacon Hill, Tulare County, California, on 24 March 1991 by D. Ubick, T. Briggs, and W. Rauscher, deposited at CAS.

ETYMOLOGY.— The specific name refers to the long ventral plate setae of the male.

DIAGNOSIS.— This species differs from all sitalcinoids, except *T. scopula*, by the combination of eyes absent, tarsal count 3-5-5-5, and cuticular ornamentation not in areolate arrangement. From *T. scopula* it is distinguished by its smaller size and genitalic differences. Males of this species most closely resemble *S. tularensis* in having strongly fused parastylar lobes, but differ in having long ventral plate setae.

DESCRIPTION.— Body length 0.98–1.20, LII/SL 3.17–3.37 ($N = 6$). Color pale orange, appendages lighter. EM low, eyes absent (lacking both retina and cornea). Body finely rugose, not in areolate pattern; scute lacking AT. GO quadrate, apically truncate, wider than long. Palpal megaspinules: trochanter 0; femur 3 ventrobasal, 1 mesoapical; patella 2 mesal, 1 ectal; tibia and tarsus each with 2 mesal, 2 ectal. TC, 3-5-5-5.

Male, holotype (paratypes, $N = 2$): Body length 1.07 (0.98–1.20). Scute length 0.72 (0.65–0.73), width 0.69 (0.69–0.78). EM length 0.18 (0.16–0.18), width 0.20 (0.18–0.20), height

0.12 (0.11–0.12). GO length 0.13 (0.13), width 0.17 (0.17–0.19). Leg II length 2.35 (2.35–2.46), LII/SL 3.27 (3.27–3.62). TrIV lacking process. Penis VP subquadrate, with 10–12 pairs of setae, distal longest, 3 pairs on lateral margin of which 2 pairs appear to have dorsal origin (Fig. 41e), AS absent; glans apically divided into two short lobes, dorsal broad and rounded (PSL) and ventral narrow and pointed (S).

Female, allotype (2 paratypes): Body length 1.08 (1.05–1.10). Scute length 0.76 (0.72–0.76), width 0.76 (0.76–0.81). EM length 0.165 (0.165–0.18), width 0.19 (0.18–0.20), height 0.12 (0.10–0.12). GO length 0.12 (0.12–0.14), width 0.17 (0.17–0.18). Leg II length 2.41 (2.38–2.43), LII/SL 3.17 (3.17–3.31). Ovipositor similar to that in *T. tularensis*, but with tips bifurcate.

Sexual dimorphism.—None observed.

NATURAL HISTORY.—Specimens have been collected in grasslands from beneath rocks, serpentine (Twin Buttes) and granite (Bacon Hill), in March.

MATERIAL EXAMINED.—CALIFORNIA: **Tulare Co.**: Bacon Hill, grassland, under granite, 24 March 1991 (D. Ubick, T. Briggs, W. Rauscher, CAS, CDU), male holotype, female allotype, 1 male (SEM), 1 female (SEM); Twin Buttes, grassland, under serpentine, 28 March 1991 (D. Ubick, T. Briggs, W. Rauscher, CAS, CDU), 1 male, 1 female. All specimens paratypes, unless indicated otherwise.

DISTRIBUTION.—Known only from the two localities in Tulare County, California.

***Tularina scopula* (Briggs, 1968), comb. nov.**

Figs. 37i–k, 42–43.

Sitalcina scopula Briggs, 1968:28. Kury, 2003:220.

TYPE MATERIAL.—Male holotype from beneath granite boulder in moist grassland pasture, 2.8 miles NW Fountain Springs, Tulare County, California, collected on 19 March 1967 by T. Briggs, K. Hom, and A. Jung, deposited at CAS, examined.

DIAGNOSIS.—This species differs from all sitalcinoids, except *T. plumosa*, by the combination of eyes absent, tarsal count 3-5-5-5, and cuticular ornamentation not in areolate arrangement. From *T. plumosa*, it is distinguished by its larger size and genitalic differences. The male differs from all other phalangodids by the ornate ventral plate, mesoapically produced and fringed with very long setae. The female is the only known blind sitalcinoid lacking ovipositor microspines.

DESCRIPTION.—Body length 1.48–1.70, LII/SL 3.38–3.82 (N = 5). Color yellowish-orange to yellowish-brown, appendages paler. Body finely rugose, not in areolate arrangement, tergites lacking marginal tubercles; scute lacking AT. EM low and flattened, eyes absent (both retina and cornea). GO quadrate-oval, wider than long. Palpal megaspines: trochanter 0; femur 3 ventrobasal, 1 mesoapical; patella 2 mesal (distal small), 1 ectal; tibia and tarsus with 2 mesal, 2 ectal. TC, 3-5-5-5.

Male, holotype: Body length 1.48. Scute length 1.05, width 1.07. EM length 0.23, width 0.28, height 0.15. GO length 0.19, width 0.29. Leg II length 4.01, LII/SL 3.82. TrIV with ventral tubercle. Penis VP entire with spatulate mesoapical elongation, with about 12 pairs of long apical setae and about 6 pairs of short basal setae, AS absent; glans with short pointed DL, PSL fused along dorsal margin; S ventral, curved, claw-like, with slender subapical tubule.

Female, allotype (additional specimens, N = 3): Body length 1.56 (1.56–1.70). Scute length 1.18 (1.15–1.18), width 1.17 (1.10–1.19). EM length 0.23 (0.225–0.24), width 0.25 (0.25–0.27), height 0.15 (0.15). GO length 0.20 (0.175–0.20), width 0.30 (0.29–0.31). Leg II length 4.32 (3.99–4.32), LII/SL 3.66 (3.38–3.66). TrIV lacking ventral tubercle. Ovipositor surface with longitudinal folds, lacking microspines, apical teeth absent, with 7 pairs of apical setae, curved, bifurcate.

Sexual dimorphism.— The male has a ventral tubercle on the TrIV, lacking in female.

NATURAL HISTORY.— Specimens, all from beneath granite boulders in a grassland, have been collected in January and March.

MATERIAL EXAMINED.— CALIFORNIA: **Tulare Co.**: 11 mi SE Porterville, under granite in level marshland, 22 January 1967 (A. Jung, CAS), 1 female paratype; 2.8 mi NW Fountain Springs, moist grassland, under granite, 19 March 1967 (T. Briggs, K. Hom, A. Jung, CAS), male holotype, female allotype, 4 female paratypes; same locality, 26 January 1991 (D. Ubick, M. Moody, CDU), 1 male (SEM); ca 3 mi N Fountain Springs, N35°55'52", W118°56'17.1", grassland, under granite, 18 January 2004 (D. Ubick, CDU), 2 females (SEM).

DISTRIBUTION.— Known only from the type locality. The different mileages refer to a single patch of granite outcrop, approximately 50 meters in diameter.

Genus *Megacina* Ubick and Briggs, gen. nov.

TYPE SPECIES: *Sitalcina cockerelli* Goodnight and Goodnight, 1942.

DIAGNOSIS.— The male genitalia of *Megacina* are unique among the known phalangodids in having a glans which folds asymmetrically onto the truncus (Fig. 44). Males also differ from other sitalcinoids in having a ventral plate with a dense vestiture of short setae and, except for *Sitalcina lobata*, a threadlike stylus (Fig. 44). The female ovipositor lacks microspines, as in *Tularina scopula* and *Enigmina granita*.

ETYMOLOGY.— The genus name is a contraction of *Mega* (Gr., large) and *Sitalcina* and is considered feminine in gender.

DESCRIPTION.— Body length 1.20–2.50. Dorsal sculpturing tuberculate or areolate; scute with 1–2 (–8) pairs of small AT. EM angular to rounded, eyes present. Cheliceral base with moderate to abrupt dorsodistal swelling. TC, 3-5-5-5.

Male: Penis with VP entire, bearing 15–25 pairs of short to medium length setae; glans with asymmetrical folding, DL absent or pointed and sac-like, PSL bilobed, fused or free; S long and slender.

Female: Ovipositor cuticle lacking microspines, with 7 pairs apical setae, straight to slightly curved and with pointed tips.

Sexual dimorphism: Male with enlarged or more tuberculate TrIV, with enlarged palpi and modified megaspines (*M. cockerelli*), with modified genital operculum (*M. madera*).

INCLUDED SPECIES.— Contains the previously described *M. cockerelli* (Goodnight and Goodnight) and *M. madera* (Briggs), and the new species, *M. mayacma* and *M. schusteri*.

DISTRIBUTION.— Known from the Sierran foothills and the north central Coast Ranges, California, and extending into SW Oregon.

Key to the Subgroups of *Megacina*

1. Cuticle areolate, at least in part (Figs. 45b–c, 47a, 49a–b); cheliceral boss absent (Figs. 45b–c); TrIV with ventrodistal swelling, lacking tubercles (Fig. 45e); FmIV with ventrobasal process (Fig. 45e) *M. madera* group
- Cuticle tuberculate (Fig. 51); cheliceral boss present (Figs. 51b–d); TrIV with tubercles, lacking ventrodistal swelling (Figs. 52f–j); FmIV lacking ventrobasal process *M. cockerelli* group

Megacina madera group

DIAGNOSIS.— Members of this species group differ from other sitalcinoids in having a ven-

trobasal process on femur IV, which is present in both sexes. The scute cuticle is areolate, unlike that in the *cockerelli* group. The male penis (Figs. 44c–i) lacks a dorsal lobe and has the parastylar lobes bilobed and fused dorsally (see discussion of homology in Phylogeny). The female ovipositor lacks microspines and has curved, pointed apical setae (Fig. 48f–i).

INCLUDED SPECIES.— *M. madera* (Briggs), *M. mayacma* sp. nov., *M. schusteri* sp. nov.

DISTRIBUTION.— Sierran foothills and north central Coast Ranges, California.

***Megacina madera* (Briggs, 1968), comb. nov.**

Figures 44g–i, 45–46.

Sitalcina madera Briggs, 1968:17. Kury, 2003:220.

TYPE MATERIAL.— Male holotype from beneath granite boulders in yellow pine and oak forest 5 mi S of Coarsegold, Madera County, California, collected on 16 April 1967 by T. Briggs, deposited at CAS, examined.

DIAGNOSIS.— This species differs from other *Megacina* by the form of the male glans, which has the dorsal part of the parastylar lobe rounded and bilobed, the ventral spatulate, and a straight stylus.

DESCRIPTION.— Body length 1.42–1.84, LII/SL 3.25–3.58 (N = 5). Color yellowish-orange, appendages lighter. Body covering of fine tubercles, in areolate arrangement on posterior dorsum, with larger tubercles along tergal margins and on scute, transversely in posterior half and in dorsal line through eyemound; scute with 2–3 pairs of small AT. EM rounded, eyes present. Palpal femur with dorsal row of a few setae, lacking mesal tubercle. Palpal megaspines: trochanter 0; femur 3 ventrobasal, 1 mesodistal (and apical seta); patella 2 mesal (1 short), 1 ectal; tibia 2 mesal (and setose tubercle), 3 ectal; tarsus 2 mesal, 2 ectal. Leg IV with Tr unmodified and Fm with short ventrobasal process in both sexes. TC, 3-5-5-5.

Male, holotype (paratype): Body length 1.84 (1.48). Scute length 1.26 (0.88), width 1.26 (1.12). EM length 0.28 (0.22), width 0.32 (0.24), height 0.22 (0.20). GO length 0.16 (0.16), width 0.16 (0.18). Leg II length 4.10 (2.96), LII/SL 3.25 (3.36). GO apically excavated. Penis VP entire with rounded apex, lacking extension, AS absent, distal third with 16 to 20 pairs of short setae, including 1 dorsoapical pair; glans with PSL bilobed, ventral ribbon-like, apically spatulate, dorsal rounded, basally fused; S basally wide, apically attenuated, slightly curved, extending beyond PSL by less than PSL length.

Female, allotype (2 paratypes): Body length 1.66 (1.42–1.66). Scute length 1.10 (1.04–1.10), width 1.18 (1.00–1.18). EM length 0.26 (0.22–0.26), width 0.28 (0.26–0.28), height 0.20 (0.18–0.22). GO length 0.18 (0.14–0.18), width 0.18 (0.18–0.20). Leg II length 3.54 (3.54–3.58), LII/SL 3.22 (3.22–3.44). GO apically rounded. Ovipositor surface finely wrinkled, lacking microspines; apical teeth absent, apex with 6 pairs setae, curved, pointed.

Sexual dimorphism.— The male has the GO apically excavated (rounded in the female), the cuticle less distinctly areolate, and FmIV process longer than in female.

NATURAL HISTORY.— Specimens have been collected beneath serpentine and granite boulders in yellow pine and oak forest, from January to June.

MATERIAL EXAMINED.— CALIFORNIA: **Madera Co.:** 5 mi S of Coarsegold, yellow pine and oak, under granite, 16 April 1967 (T. Briggs, CAS), male holotype, female allotype, 1 male (SEM) and 2 female paratypes (SEM); 4 mi SW Coarsegold, under board, 16 January 1995 (W. Tyson, CDFA), 1 male. **Mariposa Co.:** 0.7 mi N of Bagby, under serpentine, 12 June 1966 (T. Briggs, CAS), 1 female (SEM).

DISTRIBUTION.— Known from Madera and Mariposa Counties, California.

Megacina schusteri Ubick and Briggs, sp. nov.

Figures 44c–d, 47–48.

TYPE MATERIAL.— Male holotype collected from beneath meta-volcanic rock in dense oak-pine forest just E of Miocene Circle (0.2 mi SE of Pentz Road and ca. 14 mi N of Oroville), N39°40'18.5", W121°34'3.2", Butte County, California, on 3 May 2005 by D. Ubick and T. Briggs, deposited at CAS.

ETYMOLOGY.— The name honors the late Robert Schuster, a collector of this and many other rare phalangodid species.

DIAGNOSIS.— The male of this species differs from others in the group by the form of the parastylar lobe: dorsal part narrow, curved, and apically produced; ventral serrated (Figs. 48a–c).

DESCRIPTION.— Body length 1.36–1.60, LII/SL 2.93–4.26 (N = 7). Color orange, appendages lighter. Body covering of fine tubercles in areolate arrangement, with larger tubercles on eyemound, in transverse rows on scute, and along tergal margins; scute with 1–2 pairs of small AT. EM low, rounded, eyes present. Chelicera lacking laterobasal projection (boss), basal segment with abrupt dorsodistal swelling. Palpal femur with dorsal row of 5 setae, lacking mesal tubercle. Palpal megaspines: trochanter 0; femur 3 ventrobasal, 1 mesodistal (and 1 distal seta); patella 2 mesal (distal small), 1 ectal; tibia 2 mesal, 2 ectal (and 1 basal seta); tarsus 2 mesal, 2 ectal. TrIV lacking spur, but femur with short ventrobasal process. TC, 3-5-5-5.

Male, holotype (paratypes, N = 4): Body length 1.45 (1.36–1.60). Scute length 0.95 (0.91–1.05), width 0.90 (0.92–1.12). EM length 0.20 (0.17–0.25), width 0.23 (0.22–0.30), height 0.15 (0.13–0.24). GO length 0.15 (0.15–0.22), width 0.16 (0.16–0.20). Leg II length 3.52 (3.08–3.56), LII/SL 3.71 (2.93–3.87). GO subrectangular, apically truncate. Penis VP entire with rounded apical extension, bearing 15 pairs of lateral and 1 pair of dorsodistal setae, AS absent; glans with PSL venter serrate, dorsum fused, elongate, bent; S long, slender, curved.

Female, allotype (paratype): Body length 1.50 (1.45). Scute length 0.90 (0.90), width 0.99 (1.00). EM length 0.17 (0.19), width 0.23 (0.23), height 0.15 (0.15). GO length 0.16 (0.17), width 0.19 (0.18). Leg II length 3.58 (3.38), LII/SL 3.98 (4.26). GO subtriangular, apically rounded. Ovipositor surface lacking apparent microspines, apical teeth absent, apex with 6 pairs setae, curved, apically pointed.

Juvenile (N = 2, larger instar in parentheses): Body length 0.64 (0.90). Scute length 0.46 (0.62), width 0.36 (0.55). EM length 0.08 (0.12), width 0.10 (0.16), height 0.03 (0.10). GO not visible. Leg II length 1.76 (2.83), LII/SL 3.83 (4.56). *Earlier instar*: Color white with yellowish diverticula visible through abdominal cuticle. Body finely rugose, lacking larger tubercles. Dorsum of abdomen and legs with erect thick setae (not in later instar or adults). EM low, rounded, eyes present. Palpal megaspines: trochanter 0; femur 1 ventrobasal, 0 mesodistal; patella 1 mesal, 0 ectal; tibia 1 mesal, 1 ectal; tarsus 2 mesal, 1 ectal. Legs with conspicuous macrosetae (not evident in adults). Front tarsi with single claw, hind tarsi with arolium, claws not visible at 100x. TC appears to be 1-1-2-2. *Later instar*: Color and rugosity as in earlier instar. EM higher, rounded, eyes present. Chelicera basal segment with conspicuous dorsodistal swelling. Palpal megaspines: trochanter 0; femur 3 ventrobasal (distal small), 1 mesodistal; patella 1 mesal, 1 ectal; tibia 2 mesal, 2 ectal; tarsus 2 mesal, 2 ectal. Front tarsi with single claw, hind tarsi with arolium, claws not visible at 100x. TC appears to be 2-2-3-3.

Sexual dimorphism.— The male has more strongly modified leg IV: a larger ventrobasal process on the femur and a ventral swelling on the trochanter. Females have slightly longer legs than males.

Variation.— The males from Dry Creek Road are both larger and have relatively shorter legs than those from Miocene Circle.

NATURAL HISTORY.— The type locality is a gully in a dense forest of primarily live oaks with some digger pine and large manzanita. Specimens were found on the undersides of large (boulder-sized) meta-volcanic rocks, under mesic conditions. No specimens were found beneath smaller rocks and decaying logs. Most of the specimens, 4 adults and 1 juvenile, were collected beneath one large rock, two of the adults being in close proximity. Collembola and campodeiform diplura, typical indicators and probable prey of these phalangodids, were common.

MATERIAL EXAMINED.— CALIFORNIA: **Butte Co.:** Dry Creek Road, 14 mi N Oroville, 2 March 1956 (R. Schuster, UCB), 2 male paratypes. E of Miocene Circle, 0.2 mi SE of Pentz Road (ca. 14 mi N Oroville), N39°40'18.5", W121°34'3.2", under meta-volcanic rocks in dense oak-pine forest, 3 May 2005 (D. Ubick, T. Briggs, CAS), male holotype, female allotype, 2 male paratypes (SEM), 1 female paratype (SEM), 2 juveniles.

DISTRIBUTION.— The species is known only from the above two localities. The "Dry Creek Road" referred to by Schuster could not be located on topographic maps of the region. It is likely that the locality is actually along Messilla Valley Road, which is the only road paralleling Dry Creek. This area is about 1 kilometer due west from the type locality.

***Megacina mayacma* Ubick and Briggs, sp. nov.**

Figures 2h, 3h, 44e-f, 49-50.

TYPE MATERIAL.— Male holotype and female allotype collected under serpentine rocks along Socrates Mine Road, 10.8 mi W Hwy 29, Mayacma Mountain, Sonoma County, California, on 2 March 1968 by T. Briggs, deposited in CAS.

ETYMOLOGY.— The species name refers to the type locality, Mayacma Mountain.

DIAGNOSIS.— This species differs from other *Megacina* by the form of the male parastylar lobes, which are attenuated ventrally and serrate and fused dorsally (Figs. 50a-f).

DESCRIPTION.— Body length 1.18-1.76, LII/SL 2.96-3.50 (N = 6). Color yellowish-orange, appendages lighter. Body covering of fine tubercles, in areolate arrangement, with larger tubercles along tergal margins and on scute, transversely in posterior half and with few in dorsal line through eyemound; scute with 2-3 pairs of small AT. EM low, eyes present. Cheliceral basal segment with strong dorsodistal swelling. Palpal femur with dorsal row of a few setae, lacking mesal tubercle. Palpal megaspines: trochanter 1, small; femur 3 ventrobasal, 1 mesodistal (and 1 distal seta); patella 2 mesal (apical small), 1 ectal; tibia 2 mesal (and 1 apical seta), 2 ectal (and 1 basal seta); tarsus 2 mesal, 2 ectal; Leg IV lacking trochanteral process, but with short ventral process at base of femur. TC, 3-5-5-5.

Male, holotype (paratype): Body length 1.76 (1.28). Scute length 1.04 (0.92), width 1.18 (0.96). EM length 0.22 (0.20), width 0.30 (0.24), height 0.16 (0.18). GO length 0.16 (0.16), width 0.20 (0.18). Leg II length 3.64 (2.96), LII/SL 3.50 (3.22). TrIV spur absent. GO rounded, subhexagonal. Penis VP entire with rounded apical extension, lacking AS, distal half with about 20 pairs of short setae, absent from median region; glans with PSL ventral lobe slender, attenuated, dorsal serrate, fused; S long, slender, curved, extending beyond PSL by more than length of PSL.

Female, allotype (3 paratypes): Body length 1.46 (1.18-1.40). Scute length 1.04 (0.84-0.96), width 1.12 (0.86-1.00). EM length 0.22 (0.20-0.22), width 0.24 (0.20-0.22), height 0.16 (0.16). GO length 0.18 (0.14-0.18), width 0.20 (0.20). Leg II length 3.42 (2.66-3.10), LII/SL 3.29 (2.96-3.26). GO rounded, hemispherical. Ovipositor bent when fully expanded, surface finely wrinkled, lacking microspines, apical teeth absent, with 6 pairs of setae, curved, pointed.

Sexual dimorphism.— The areolate cuticle is more strongly defined in the female and the ventrofemoral process and trochanter on leg IV is slightly larger in the male.

NATURAL HISTORY.— Most specimens have been collected beneath serpentine boulders in oak

forests. Other specimens are from a mixed forest, a cypress grove, and from beneath pine logs. Collections are from January through March. This species has been collected sympatrically with *Megacina cockerelli* in Sonoma County (Healdsburg).

MATERIAL EXAMINED.— CALIFORNIA: **Lake Co.:** 1.5 mi W of Adobe Creek Reservoir on Highland Spring Road, under serpentine in cypress grove, 3 March 1968 (T. Briggs, CAS), 3 males (1 SEM), 8 females (1 SEM). **Mendocino Co.:** Hopland, Feliz Creek Road, under serpentine in oak woodland, 21 January 1991 (D. Ubick, CDU), 2 males (SEM), 2 females; 3 mi S of Hopland on Country Road # 111, under serpentine, 3 March 1968 (T. Briggs, CAS), 5 males, 6 females; 3.5 mi S of Hopland on road to Hwy 128, under serpentine in oak woodland, 10 February 1985 (T. Briggs, CAS), 1 female. **Sonoma Co.:** 1.5 mi NE Healdsburg, 11 January 1981 (T. Briggs, CAS), 1 male; 7 March 1982 (D. Ubick, CDU), 1 male; Mayacma Mountain, Socrates Mine Road, 10.8 mi W Hwy 29, under serpentine, 2 March 1968 (T. Briggs, CAS), holotype male, allotype female, 2 additional females; 9.8 mi W of Hwy 29, under pine logs, 2 March 1968 (T. Briggs, CAS), 4 males, 9 females; Pine Flat Road, 2.0 mi NE Highway 128, N38°41', W122°47', recently burned digger pine-chaparral, under serpentine rocks, 9 January 2007 (D. Ubick, T. Briggs, CDU), 4 males, 3 females; 5.7 mi NE Red Winery Rd. on Pine Flat Rd., mixed forest, under serpentine, 3 January 1993 (D. Ubick, T. Briggs, W. Rauscher, CAS), 3 males, 5 females. All specimens are paratypes, unless indicated otherwise.

DISTRIBUTION.— Known from the north central Coast Ranges, California.

Megacina cockerelli group

DIAGNOSIS.— *Megacina cockerelli*, the only representative of this group, is the largest of the sitalcinoids and the only one with a cheliceral boss (Figs. 51a-d). Males differ from those in the *madera* group in having a dorsal lobe which is pointed (flap-like in *Microcina* and *Sitalcina*) and the parastylar lobes separate, not fused dorsally (Fig. 53). The species has a sexually dimorphic palp (tibia enlarged in male and with additional megaspines, patella with enlarged and displaced ectal megaspine, Fig. 52) and TrIV (more heavily tuberculate in male, Fig. 52). The female has the unique combination of the ovipositor typically bent, the cuticle glabrous and wrinkled, and the apical setae short and straight (Fig. 54).

INCLUDED SPECIES.— Only *M. cockerelli* (Goodnight and Goodnight).

DISTRIBUTION.— North to central coast of California.

Megacina cockerelli (Goodnight and Goodnight, 1942), comb. nov.

Figures 1, 2i, 3i, 51-54.

Sitalcina cockerelli Goodnight and Goodnight, 1942:9. Briggs and Hom, 1966:263. Briggs 1968:18. Briggs and Ubick, 1989:214. Edgar, 1990:539. Kury, 2003:220.

TYPE MATERIAL.— "Female" holotype from Myers Auto Camp, Redwood Highway, California, collected by T.D.A. Cockerell, deposited at AMNH, examined. Note—The holotype is actually a male with a fully extruded penis.

DIAGNOSIS.— Same as for species group.

DESCRIPTION.— Body length 2.08-3.02, LII/SL 2.85-4.37 (N = 11). Color yellowish-orange, appendages lighter. Body finely rugose with larger tubercles on eyemound dorsum, and in transverse rows on scute posterior and along tergal margins; scute with 1-8 pairs of small AT. EM angular, eyes present. GO rounded subtriangular. Cheliceral basal segment with lateral swelling (boss). Palpal femur with dorsal row of few setae, lacking mesal tubercle. Palpal megaspines: trochanter 1, small; femur 3 ventrobasal, 2 mesodistal (distalmost small); patella 2 mesal, 1 ectal; tibia 2 mesal, 2 ectal; tarsus 2 mesal, 2 ectal. TC, 3-5-5-5.

Male, holotype (additional specimens, N = 5): Body length 2.72 (2.16-3.02). Scute length 1.96

(1.78-2.22), width 1.82 (1.70-2.04). EM length 0.45 (0.40-0.58), width 0.50 (0.48-0.64), height 0.35 (0.35-0.46). GO length 0.26 (0.26-0.32), width 0.26 (0.26-0.30). Leg II length 5.58 (5.58-7.94), LII/SL 2.85 (2.85-4.17). TrIV spur absent, but with few to several ventral tubercles. Palpal tibia with several spinose tubercles between the megaspines; patella with basal megaspines enlarged and contiguous. Penis VP entire with slight apical extension, with 13-16 pairs lateral, 1 pair dorsoapical setae, AS absent; glans folds asymmetrically, with dorsal and ventral surfaces in lateral position when folded, DL conical when expanded, PSL bilobed, with complex ornamentation; S long, slender, apically notched, basally swollen.

Female (N = 5): Body length 2.08-2.68. Scute length 1.50-2.00, width 1.44-1.92. EM length 0.30-0.46, width 0.34-0.52, height 0.24-0.40. GO length 0.24-0.30, width 0.28-0.30. Leg II length 5.60-7.10, LII/SL 2.92-4.73. Palpal tibia lacking tubercles associated with the megaspines; patella with basal megaspines separated. TrIV with small ventral tubercle, sometimes absent. Ovipositor surface finely wrinkled, lacking microspines, apical teeth absent, with 7 pairs of short, straight apical setae.

Variation— Members of this species show much somatic variation. Some specimens (from Marin County) have missing retinae, and individuals also vary in body size and relative appendage length. However, the most important differences are those between the northern and southern populations. In general, specimens from the north (to Mendocino County) are more strongly tuberculate, having increased AT and more TrIV tubercles, especially in males (Figs. 52f, g). These males also have additional mesoapical setiferous tubercles on the palpal femur (Fig. 52b) and palpal patellae with somewhat longer mesobasal megaspines. There are also differences in the male genitalia, principally in the proportions of the glans lobes (Figs. 44a-b). Closer study is needed to determine whether this variation represents additional species.

Sexual dimorphism.— Male TrIV with few to several tubercles, female typically with a single small one. Male palpal tibia enlarged, with several spinose tubercles associated with megaspines (Fig. 52c); absent in female. Male palpal patella with megaspines enlarged, contiguous (Fig. 52c), and more basal than in female (Fig. 52d).

NATURAL HISTORY.— Most specimens have been collected in dense forests, especially redwood, fewer records are from oak grassland and chaparral. The species occurs in a wide variety of habitats, having been collected from beneath rocks, under and within decomposing logs and fallen bark, and in various types of leaf litter. Individuals of both sexes have been collected in about equal abundance and throughout the year, although most commonly from January through June. This species is fully sympatric with the phalangodids *Calicina sequoia* (Briggs) and *Sitalcina californica* (Banks), largely parapatric with *Megacina mayacma* sp. nov., and largely pseudosympatric with *Microcina* species, which are typically found in grasslands.

MATERIAL EXAMINED.— OREGON: Coos Co.: Camp Myrtlewood, nr Bridge, 28-31 July 1954 (V. Roth, CAS), 2 males; Charleston, 28 August 1947 (I. Newell, JCC), 1 male; Charleston, woods behind Marine Biological Institute, berlese of spruce, cedar, alder duff, 30 April 1967 (E. Benedict, WAS), 1 male, 1 female; 33.9 mi S Charleston, 2 September 1970 (T. Briggs, CAS), 1 male, 1 female. Curry Co.: Boardman State Park, 18 June 1966 (T. Briggs, V. Lee, K. Hom, A. Jung, CAS), 5 males (SEM), 6 females (SEM), 1 juvenile; 2 mi N Brookings, 31 September 1959 (V. Roth, AMNH), 2 males, 2 females; 7 mi N, 3 mi W Brookings, T40S/R14W/S4, 12 February 1972 (E. Benedict, CWS), 1 female; 7 mi E Brookings, Myrtle Grove, Chetco River, 29 May 1952 (V. Roth, CAS), 2 males; Geisel Mon. State Park, 1.5 mi SSE Nesils Beach, berlese of sitka spruce litter from under sword fern, no date (no collector, CAS), 1 female; Gold Beach, Douglas fir duff, 21 June 1955 (J. Capizzi, CAS), 1 female; 4.5 mi S Gold Beach, 19 June 1966 (T. Briggs, V. Lee, A. Jung, K. Hom, CAS), 8 males, 4 female, 4 juveniles; virgin spruce fern forest, under spruce bark on ground, 29 January 1967 (K. Hom, V. Lee, T. Briggs, CAS), 2 males, 5 females, 1 juvenile; 2 September 1970 (R. Lem, W. Lum, CAS), 1 male, 1 female; old growth forest, 1 August 2000 (T. Briggs, CAS), 2 males, 1 female; 8 mi

E Gold Beach on Rogue River, 28 May 1952 (V. Roth, CAS), 1 male, 1 juvenile; 3 mi E Pistol River on Pistol River Road, 18 June 1966 (V. Lee, K. Hom, CAS), 2 males, 6 females; 1 mi N Sixes, 30 September 1959 (V. Roth, AMNH), 1 male, 1 female.

CALIFORNIA: **Del Norte Co.:** nr. Crescent City, Smith River, redwood duff, 9 November 1956 (J. Schuh, JCC), 1 female; 2.1 mi NE Crescent City on Hwy 101, 25 June 1966 (K. Hom, CAS), 1 male, 1 female; 6 mi NE Crescent City, 25 June 1978 (J. Schuh, L., N. Herman, AMNH), 1 female; nr. N entrance Del Norte Coast Redwoods State Park, 18 June 1966 (V. Lee, CAS), 1 male, 1 female; 1.6 mi N Del Norte Coast Redwoods State Park, 25 June 1966 (A. Jung, K. Hom, T. Briggs, V. Lee, CAS), 2 males, 2 females, 1 juvenile; Ft. Dick, berlese of redwood litter, 2 December 1966 (C. Obrien, CAS), 1 male (SEM), 2 females, 1 juvenile; 0.3 mi SE E entrance of Jedediah Smith Redwoods State Park, 25 June 1966 (A. Jung, K. Hom, CAS), 4 males, 1 female; Smith River Cutoff, redwood forest, 13 October 1954 (V. Roth, CAS), 1 male, 1 female. **Humboldt Co.:** Arcata Redwood Tree Farm, nr. Prairie Creek State Park, 18 June 1966 (V. Lee, CAS), 1 female; Benbow, nr. Richardson Grove, 19 July 1962 (V. Roth, AMNH), 1 female; Carlotta, 15 September 1961 (W. Ivie, W. Gertsch, AMNH), 1 male, 2 females; 1 mi S Dyerville, 19 September 1953 (E. Gilbert, R. Schuster, AMNH), 1 male; 0.5 mi S Founder's Tree, Dyerville, 18 August 1947 (Remington, AMNH), 1 male, 1 female; Freshwater, 13 August 1953 (C. Marsh, R. Schuster, AMNH), 1 female; 2.9 mi S Garberville, under log, 13 March 1966 (K. Hom, CAS), 1 female; Humboldt Redwoods State Park, Founder's Grove, redwood duff, 28 October 1990 (D. Ubick, W. Rauscher, CDU), 3 males, 5 females, 5 juveniles (3 instars); Myers Auto Camp, Redwood Hwy, no date (T. Cockerell, AMNH), 1 female (holotype); nr. Orick, 18 June 1966 (V. Lee, K. Hom, CAS), 2 males, 1 female, 2 juveniles; 1 mi N Pepperwood, redwood forest, under redwood logs, 25 January 1967 (T. Briggs, V. Lee, CAS), 5 males, 1 female; Trinidad, 16 July 1968 (W. Ivie, AMNH), 1 female; Underwood Park, nr Garberville, 13 March 1966 (T. Briggs, K. Hom, CAS), 2 males, 2 females. **Mendocino Co.:** Cummings, under rocks, 12 March 1966 (K. Hom, CAS), 2 females; 6 air mi E Cummings, oak forest, under serpentine, 19 October 1989 (D. Ubick, W. Rauscher, CDU), 1 male, 1 female; Mill Creek County Park, oak-bay forest, under rocks, 5 May 1991 (D. Ubick, CDU), 3 females; Noyo River, 14.5 air mi E Ft. Bragg, W123°32', N39°25.5', under log in redwood forest, 25-26 May 1996 (D. Ubick, CAS), 1 female; 2.3 mi S Piercy, under rocks and logs in redwood forest, 13 March 1966 (K. Hom, T. Briggs, CAS), 21 males, 10 females, 5 juveniles; 18 June 1966 (V. Lee, K. Hom, CAS), 5 females; 4.2 mi S Piercy, 17 February 1967 (V. Roth, AMNH), 1 female, 1 juvenile; Rockport, 17 February 1967 (V. Roth, AMNH), 1 female; 3.0 mi S Rockport, el 300', under redwood logs, 19 September 1990 (D. Ubick, CDU), 1 juvenile; Spyrock Road, 9.2 mi NE Hwy 101, el 2100', oak-madrone litter, 21 September 1990 (D. Ubick), 1 male, 1 juvenile; 1 mi N Squaw Rock on Hwy 101, 13 March 1966 (T. Briggs, K. Hom, CAS), 3 females; nr E entrance Standley State Park, 4 July 1966 (K. Hom, CAS), 2 males, 1 female; 5 mi S Usal Creek, 17 April 1976 (T. Briggs, CAS), 1 male, 1 female; 2.0 mi S Usal Campground, el 1000', under redwood logs, 19 September 1990 (D. Ubick, CDU), 2 females, 3 juveniles; 1 mi NE Usal Road along Hwy 1, el 200', redwood duff, 20 September 1990 (D. Ubick, CDU), 1 male, 2 juveniles; 9.8 mi SW Hwy 101, along Hwy 1, el 1000', redwood duff, 20 September 1990 (D. Ubick, CDU), 1 female, 1 juvenile. **Sonoma Co.:** Bohemian Hwy., 2.4 mi SE Monte Rio, N38°26'37", W 122°59'19", oak-chaparral, under serpentine, 20 December 2001 (T. Briggs, G. Giribet, D., S. Ubick, CAS), 1 male, 1 female; nr El Verano, junction of Spring and Prospect Roads at Diamond Estates Recreation Area, 18 January 1988 (T. Briggs, CAS), 1 female; 3.5 mi W El Verano, broadleaf evergreen forest, under volcanic rocks, 6 February 1988 (T. Briggs, D. Ubick, V. Lee, CAS), 3 males, 3 females, 4 juveniles; Franz Creek, just E Chalk Hill Road, redwood forest, under logs, 12 April 1990 (D. Ubick, T. Briggs, W. Rauscher, B. Lym, CAS), 2 females; 5 mi due E Geyserville, 25 February 1968 (T. Briggs, CAS), 1 male; 1.5 mi NE Healdsburg, mixed broadleaf forest, under volcanic rocks, 11 January 1981 (T. Briggs, CAS), 2 females; 27 December 1980 (D. Ubick, CAS), 1 male; 13 January 1991 (D. Ubick, W. Savary, K. Dabney, CDU), 1 male, 2 females; 2.3 km E Healdsburg on Bailache Ave., 90 m el, 21 December 1981 (T. Briggs, D. Ubick, V. Lee, CAS), 1 female; NE of Healdsburg, W Soda Rock Lane at Alexander Valley Road, 23 March 1968 (T. Briggs, CAS), 1 female; 17 April 1976 (T. Briggs, CAS), 1 female; W Soda Rock Lane, 0.8 mi SE Alexander Valley Road, N38°39', W122°49', madrone-oak forest, under log, 9 January 2007 (D. Ubick, T. Briggs, CDU), 1 male; Jenner, 12 February 1969 (T. Briggs, CAS), 1 male, 1 female; Mark West Springs, 13 April 1981 (T. Briggs, CAS), 1 male; nr Lytton, 0.3 mi W West Soda Rock Lane on Alexander Valley Road, 25 February 1968 (T. Briggs, CAS), 2 females; Pepperwood Ranch Natural Preserve, 10 mi N Santa Rosa,

under volcanic rocks, mixed woodland, 8 May 1993 (D. Ubick, CAS), 3 males, 1 female; Santa Rosa, redwood grove on bridge on Chalk Hill Road, 5.8 mi NE junction Pleasant and Chalk Hill Ave., 21 May 1966 (K. Hom, CAS), 1 female; 1 mi S Trenton, 15 May 1957 (R. Schuster, UCB), 1 male. **Napa Co.:** Clay Cave, nr St. Helena, N38.5435°, W122.4666°, 230m, 8 June 1980 (T. Briggs, CAS), 1 female; 26 Feb 2005, (D. Kavanaugh, CAS), 1 female; Helena, 2.5 mi W Hwy 29 on Spring St., el ca 450', mixed evergreen forest, under volcanic rocks and Douglas fir logs, 10 December 2004 (T. Briggs, H. Tu, CAS), 2 males, 2 females; Diamond Mtn Rd (=Kortum Cyn Rd), 1 mi SW Hwy 29, mixed evergreen, under volcanic rocks and Douglas fir logs, 11 December 2004 (T. Briggs, H. Tu, CAS), 2 males, 1 female; Spring Mtn Rd, 2.5 mi W Hwy 29, mixed evergreen, under volcanic rocks, 11 December 2004 (T. Briggs, H. Tu, CAS), 4 males, 1 female; nr Hennesy Dam, digger pine forest, under serpentine, 12 March 1967 (T. Briggs, CAS), 1 male, 1 female; 10 mi S Monticello, 12 May 1957 (L. Smith, R. Schuster, UCB), 1 male, 2 females; E of Napa, Skyline Wilderness Park, Camp Coombs, mixed broadleaf forest, under volcanic rock and in decomposing log, 22 January 1999 (T. Briggs, W. Rauscher, D. Ubick, CAS), 2 males, 3 females, 1 juvenile; E of Napa, Skyline Wilderness Park, Lake Marie Road, oak forest, under volcanic rock, 22 January 1999 (D. Ubick, CAS), 1 female; 4.3 mi NW Napa on Redwood Road, 21 May 1966 (T. Briggs, K. Hom, CAS), 1 male, 2 females; 1 mi W Oakville, 22 February 1968 (T. Briggs, CAS), 1 male. **Marin Co.:** W side Black Point Ridge, nr Novato, oak forest, under volcanic rocks, 12 Jan 1985 (D. Ubick, T. Briggs, CAS), 1 male; 0.75 mi E Bon Tempe Lake Dam, redwood grove, under logs, 3 April 1966 (T. Briggs, K. Hom, CAS), 2 males, 2 females; along Bootjack Trail, nr Bootjack, beneath redwood log, 27 January 1973 (T. Briggs, R. Lem, CAS), 1 male; Burdell Mountain, SE slope, Buck property, 16 March 1990 (D. Ubick, T. Briggs, CDU), 2 males (1 SEM), 3 females (1 SEM); oak grassland ecotone, under serpentine, 8 March 1991 (D. Ubick, CDU), 2 females; saddle W of Burdell Mountain, 2 Jan 1986 (D. Ubick, T. Briggs, CAS), 3 males, 4 females; Fairfax, 24 November 1947 (J. MacSwain, UCB), 1 female; Lake Lagunitas, 19 July 1966 (T. Briggs, CAS), 1 male, 1 female; Novato, Bahia Memorial Park, under rock in laurel grove, 8 February 2001 (T. Briggs, CAS), 1 female; Novato, Rush Creek Preserve, under volcanic rock, 8 March 2001 (T. Briggs, CAS), 1 male, 1 female; Ring Mountain, 27 December 1981 (T. Briggs, CAS), 1 male; serpentine grassland, 19 March 1994 (D. Ubick, CAS), 1 male; Ring Mountain, N37°54.65', W122°29.24', under serpentine boulder in grassland about 10m from oak forest, 3 March 2007 (D. Ubick, CDU), 2 males; Ross, Bald Hill, broadleaf evergreen-grassland ecotone, under basalt, 17 February 1991 (T. Briggs, P. and L. Hoch, CAS), 1 female; 1 March 1991 (D. Ubick, T. Briggs, CAS), 1 female; N side of Burdell Mtn, World College West, W side of campus, 1 mi W Hwy 101 on San Antonio Road, el 60 m, 11 January 1986 (T. Briggs, D. Ubick, V. Lee, CAS), 5 males, 15 females, 2 juveniles. **Contra Costa Co.:** Berkeley Hills, Berkeley, 16 February 1945 (Linsley, Smith, MLG), 1 male, 1 female; Redwood Peak, Oakland Hills, 5 March 1954 (H. Leech, CAS), 1 male; Tilden Park, Berkeley, 4 February 1961 (P.R. Craig, J.K. Anderson, CAS), 1 female; West Pittsburg, 21 March 1957 (J. Powell, UCB), 2 males, 1 female; Wildcat Canyon Regional Park, under bay trees, 19 March 1980 (J. Connors, CAS), 5 males; Wildcat Canyon and Hill Road, nr Richmond, bay grove, under rocks, 30 January 1984 (T. Briggs, CAS), 4 males. **Alameda Co.:** Dwight Way Hill, Berkeley, 2 feet down in ground, 12 April 1947 (J. MacSwain, CJC), 1 male.

DISTRIBUTION.—Known from the San Francisco Bay Region, California, north to southwest Oregon.

PHYLOGENY

HOMOLOGY.—The homology of most phalangodid characters studied is self-evident, being based on obvious similarities in form and placement. However, in the three situations discussed below, the homologies are unclear and so subject to interpretation.

1.—The *Tularina* glans. Two of the three known species have a very simple glans. The simplest is in *T. plumosa*, which has only two terminal lobes visible: a narrow ventral and broad dorsal (Figs. 37e-h). *T. tularensis* is similar, but has a stylus visible between the lobes, which are subequal in size (Figs. 37a-d). One interpretation of this is that the dorsal lobe of *Tularina* (DLt) is homologous to the dorsal lobe of other sitalcinoids (DLs) and, by extension, that the ventral lobe (VLt) is homologous to that of the PSL. Arguing against this, is the fact that the DLt is longer and

more apical in position than the DLs and that the VLt is a single structure, in contrast to the separate lobes of the PSL. Additionally, a different interpretation is suggested by comparison to the glans of the third species of *Tularina*, *T. scopula*. Here the glans is more complex in having two sets of lobes along the dorsal surface, a short pointed basal lobe (DL1) and a long one that is apically bifurcate (DL2). Its ventral lobe is curved and pointed and has a slender tubule originating on its dorsal surface (Figs. 37i-k). The homology of this glans to that of other sitalcinoids now seems straight forward. Both the position and length of DL1 resemble DLs. The DL2 is spatulate in shape and at least apically separate and so resembles PSL. This leaves the ventral lobe and its dorsal tubule as the stylus, as similar "tubulated" styli occur in other phalangodids (*Microcinella* and some *Calicina* species).

Comparing all three species suggests the following conclusions:

a) that the ventral lobes of *T. plumosa* and *T. tularensis* are homologous to the stylus of *T. scopula*. This is supported by their similarities in position and form, being both tapering and ventrally curving. This further suggests that the "stylus" visible in *T. tularensis* is the homologue to the styler tubule in *T. scopula*. Thus, VLt = stylus.

b) that the DLt in *T. plumosa* and *T. tularensis* are homologous to the DL2 in *T. scopula*, or DLt = DL2 = PSL.

c) that only *T. scopula* has a possible homologue of the DLs.

Thus, the glans in *Tularina* is best interpreted as having fused PSL and lacking a DL, except possibly in *T. scopula*.

2.— The *Megacina* glans. The glans in *M. cockerelli* does not pose a problem, as it has both a pair of PSL and a DL (Figs. 44a-b), although the latter is pointed, unlike the broad flap in *Sitalcina* (Figs. 13, 14a-c). However, in the *M. madera* group, the glans is much different, having only a single multipronged lobe, fused along the dorsal surface (Figs. 44c-i). Although the dorsal part of this lobe may be interpreted as a DL, it is considerably distad from the standard DL position and seems to be too rigid for a DL, which is typically membraneous and inflatable. It is more likely that this lobe represents PSL, which are dorsally fused and bilobed, and that the DL is absent.

3.— The *Enigmina* male TrIV structures. In *Enigmina*, the male TrIV has a pair of short ventral processes, one each on the mesal and ectal margins (Figs. 33d-e, 35e-f). As this combination does not exist in other sitalcinoids, it is clearly an autapomorphy for the genus. Less clear is the homology of these structures. Being small, they may be regarded as tubercles, such as the ones in male *Tularina scopula* (Fig. 42f) and *Megacina cockerelli* (Figs. 52f-g, i). But, unlike tubercles, they are somewhat larger and setiferous, as are the spurs in *Sitalcina* (Figs. 15g-h, 17f, 31g-f). Additionally, both the prongs and spurs are inserted laterally on the trochanter, whereas tubercles are typically medial (but widespread in some *Megacina cockerelli*). Thus, it is likely that the structures in *Enigmina* are probable homologues to the spurs in *Sitalcina*. Of the two prongs found in *Enigmina*, the ectal is represented in all *Sitalcina* by the much larger process (spur), but a mesal prong only occurs in *S. lobata* (Figs. 31f-g). That both *Enigmina* and *S. lobata* have similar mesal prongs seems to suggest a relationship between the two. The two taxa, however, are morphologically very different, with no other apparent synapomorphies we could detect, and *S. lobata* seems to be well nested in *Sitalcina* on the basis of both male and female genitalic characters (see diagnoses of the taxa). Our interpretation here is that the ectal processes are a synapomorphy for *Enigmina* and *Sitalcina*, and that the mesal ones are independently derived in *Enigmina* and *S. lobata*.

CHARACTER POLARITIES.— Our interpretation of the polarities of character states is discussed below and summarized in tabular form in Fig. 55. For the outgroup we used *Calicina mariposa*, which appears to be the most plesiomorphic member of the genus (Ubick & Briggs, 1989).

Penis

Glans expansion.

1.—Telescoping v folding. A telescoping glans (T) occurs in *Calicina* (Figs. 4c-e) and a folding glans (F) in all other Nearctic taxa (e.g., Figs. 14a-c), with two exceptions. In *Phalangodes et al.*, the glans is reduced in size and has a different expansion, an accordion-like folding which is yet to be fully described (see fig. 4.35g of Ubick, 2007). As these harvestmen are clearly derived in both somatic and other genitalic features, being highly nested in the bifurcate clade, their glans expansion is best interpreted as secondarily derived. The situation in *Microcinella* (Figs. 6a-b), on the other hand, where the glans both telescopes *and* folds (TF), is clearly of primary significance. Earlier (Ubick and Briggs, 1989), we had argued that the folded glans is a derived condition (T→F), but the presence of a composite (TF) glans increases the number of possible transformations, of which we see a total of five:

a) if TF = plesiomorphic, then TF→T and TF→F. Here, T and F are independently derived, which leads to an unresolved trichotomy: (T) TF (F). Although this transformation is plausible, given that the mechanism of TF is more complex than in other phalangodids (being a composite of T and F) suggests that it is not plesiomorphic, but derived.

b) if TF = apomorphic with F plesiomorphic, then F→TF. Here TF is derived from an F ancestor by gaining T, resulting in T (TF + F). This possibility is not regarded as likely since it requires the independently derivation of T, and the resulting clade, TF + F, is not supported by known synapomorphies. Additionally, the structural complexity of the F glans suggests that it is derived (elaborated below).

c) if TF = apomorphic with T plesiomorphic, then T→TF. Here TF derives from a T clade by gaining F, resulting in (T + TF) F. This is also seen as unlikely because of independent derivation of F, and the clade, T + TF, is not supported by known synapomorphies.

d) if TF = transitional state with F plesiomorphic, then F→TF→T, resulting in F (TF + T). The strongest argument that F is not plesiomorphic is that this glans type is morphologically more complex. In addition to the obvious complexity of the bifurcate clade (the deeply incised ventral plate), both *Sitalcina* and *Megacina* have complex glanses. Even the simplest F glans (in *Microcinella*) is more complex than the TF of *Microcinella* in having an additional lobe (DL, Fig. 8). Finally, the apparent simplicity of the glans in some *Tularina* has been argued above to be secondarily derived (based on apparent fusion of structures).

e) if TF = transitional state with T plesiomorphic, then T→TF→F. Here, F is derived once, resulting in T (TF + F). However, the presence of telescoping in TF, using outgroup comparison, is a plesiomorphic retention, giving T (TF (F)), or *Calicina* (*Microcinella* (other phalangodids)). For now, we provisionally accept this interpretation and regard *Calicina* and *Microcinella* as progressive outgroups to the remaining Nearctic Phalangodidae.

2.—Symmetrical v asymmetrical folding. Glans folding is symmetrical in most members of the folding glans clade (State 0). However, in *Megacina* (Figs. 44, 46, 48, 50, 53) the glans folds asymmetrically onto the truncus (State 1), with the morphologically dorsal and ventral surfaces positioned laterally in the folded glans. As this type of folding is not known in other phalangodids, it is a strong synapomorphy for the genus.

Ventral plate.

3.—Entire v bifurcate. In most phalangodids, the VP is entire (State 0), or with a short apical notch in some species of the European *Scotolemon* Lucas, 1860 and *Ausobskya* Martens, 1972. A deeply cleft VP (Figs. 5d-e) is thus derived (State 1) and a strong synapomorphy for the bifurcate clade (*Banksula*, *Texella*, and *Phalangodes et al.*, see Ubick and Briggs, 1992, 2002).

4.—Ventral v lateral. The VP is in a ventral position in *Calicina* (Figs. 4c-e) and all sitalcinoids (State 0). Within the bifurcate clade, the VP prongs are also ventral in *Banksula* (Figs. 5d-e) but lateral in the other members (see figs. 4.35f-g of Ubick 2007), where it is a synapomorphy (State 1).

5.—Apical spine. An AS is absent in *Calicina* and most sitalcinoids (State 0), so its presence

is considered derived (State 1). It is found in *Banksula* (Fig. 5f) and *Texella* and suggests another synapomorphy for the bifurcate clade, although it appears to be absent in *Phalangodes et al.* The AS is also present in *Sitalcina californica* (Figs. 16b, f), where it is probably independently derived as that species is morphologically distinct from the bifurcate clade.

6.—Dorsal setae. Dorsal setae are absent in most taxa (State 0), so that their presence in *Megacina* (Figs. 44, 46d, 48b, 53d) and the bifurcate clade (Fig. 5d) is clearly derived (State 1). A complication arises in *Tularina plumosa*, where the distal two pairs of lateral setae are dorsally displaced (Fig. 41e). Without further study, it is not clear if this condition represents a transition state or an autapomorphy for the species, and is scored as unresolved.

7.—Setal number. As fewest setae (5-6 pairs) occur in *Microcinella* (Fig. 6) and *Microcina* (Fig. 8), and only slightly more (< 9 pairs) in *Calicina* (Fig. 4d), an increased number is regarded as derived. Scoring is: < 9 pairs = State 0; 9-15 pairs = State 1; > 15 pairs = State 2.

8.—Setal length. Very short setae are found in *Microcinella* (Fig. 6) and *Microcina* (Fig. 8) and moderately longer ones in most sitalcinoids (State 0). Very long setae (State 1) are derived, and interpreted as an autapomorphy for *Sitalcina lobata* and a synapomorphy for *Tularina plumosa* and *T. scopula*.

Dorsal lobe (DL).

9.—Presence. This typically flap-like structure is present on the dorsal surface of the glans, basad of the S. As it is absent (State 0) in *Calicina* (Figs. 4c-e) and *Microcinella* (Fig. 6), its presence is regarded as derived (State 1). However, given our interpretation of homology (above), the DL is also apparently absent in *Tularina tularensis* (Figs. 37a-d), *T. plumosa* (Figs. 37e-h), and the *madera* group of *Megacina* (Figs. 44c-i), the relatively basal elements of the two genera. This suggests that the DL in *Tularina scopula* (Figs. 37j-k) and *Megacina cockerelli* (Figs. 44a-b) are independently derived. The fact that this DL in these species is a more pointed structure than found in other sitalcinoids, may support this interpretation.

10.—Size. As the DL in *Microcina* is a small flap (Fig. 8), the larger state in others is derived (State 1).

Parastylar lobes (PSL).

11.—Fusion. PSL are separate structures in all sitalcinoids except in *Tularina* (Figs. 37c-h) and the *madera* group of *Megacina* (Figs. 44c-i), where they are dorsally fused and considered derived (State 1). The separate lobes in *M. cockerelli* are interpreted as a character reversal.

12.—Complexity. In most taxa (*Calicina*, *Microcinella*, *Microcina*, and *Enigmina*), the PSL are simple rounded or pointed lobes (Figs. 4c-e, 5d-g, 6, 8, 14a-c, g-h). Ornate, multilobed PSL (State 1) are regarded as derived. In the *Sitalcina sura* (Fig. 13) and *lobata* (Figs. 14d-f) groups, they are bilobed and trilobed, respectively. Complex PSL are also present in *Megacina* (Fig. 44), but are structurally different from those in *Sitalcina* and probably represent independent origin. They are fused and bilobed in the *M. madera* group and interlocking and with papillate edges in the *M. cockerelli* group.

Stylus.

13.—Origin. The stylus typically originates at the ventral surface of the glans (Figs. 4c, 5g, 6, 8, 14g-h, 37, 44; State 0); the dorsal position in most *Sitalcina* (except *S. chalonga*) is considered derived (Figs. 13, 14a-f; State 1).

14.—Thickness. Most S are of moderate thickness (State 0), so the long slender S (State 1) of *Megacina* (Figs. 44a-b) and some *Sitalcina* (Figs. 13k, 14e), and the very short stout S (State 2) of *Enigmina* (Figs. 14g-h), are each considered derived.

Ovipositor

15.— Apical teeth. Apical teeth do not occur in basal *Calicina* (Fig. 4f), nor in the sitalcinoids (e.g., Fig. 16g-h), so their presence is derived (State 1). They are found in two species groups of *Calicina* (figs. 5e-h of Ubick and Briggs, 1989) and at least in *Banksula* (Figs. 5i) and *Texella* (figs. 18-19, 73, 154, 195 of Ubick and Briggs, 1992) of the bifurcate clade, suggesting independent derivation in the two groups.

Microspines.

16.— Presence. Microspines are found in most phalangodids, including the presumed basal elements; their absence (Fig. 54) is considered derived (State 1).

17.— Arrangement. Microspines are randomly distributed in *Microcina* (Fig. 10g), *Microcinella* (Fig. 7d), and the two basal groups of *Calicina* (Fig. 4g). The more orderly arrangements are derived: imbricate (State 1) in *Sitalcina* (Fig. 16i) and in transverse clusters (State 2) in *Tularina tularensis* and *T. plumosa* (Figs. 39j, 41i).

Apical setae.

18.— Shape. As weakly curved apical setae occur in *Calicina* (Fig. 4f), they are considered plesiomorphic (State 0). Strongly curved (hooked) setae in *Microcinella* (Fig. 7d), *Microcina* (Fig. 11e), two *Sitalcina* groups (Figs. 16g, 32g), and *Tularina tularensis* (Fig. 39h) are derived (State 1), as are straight setae in *Megacina cockerelli* (Fig. 54b) and some members of the bifurcate clade (State 2). Weakly curved setae in the remaining (more highly nested) sitalcinoids is more likely a synapomorphy (character reversal) rather than a plesiomorphic retention.

19.— Form of tip. Simple pointed setae are found in *Calicina* (Fig. 4f) and *Microcinella* (Fig. 7d), so additional points may be regarded as derived. Three derived states have been found: bifid (State 1) in *Tularina plumosa* (Fig. 41h) and *T. scopula* (Fig. 43h); trifurcate (State 2) in *Microcina* (Fig. 11g); and polyfurcate (State 3) in the *Sitalcina sura* group (Fig. 20j). The relationship between the derived states is ambiguous.

Somatic structures

20.— Eye loss. Most phalangodids have eyes, including the basal groups of *Calicina*, so their loss is clearly derived (State 1). Among the sitalcinoids, eyes are absent in *Microcinella* (Fig. 7b), *Microcina* (Fig. 9b), and *Tularina* (Fig. 40b).

21.— Anterior tubercle number. A high AT number (Fig. 4b) occurs in the basal elements of *Calicina* (Ubick and Briggs, 1989) and *Texella* (Ubick and Briggs, 1992) and is interpreted as plesiomorphic. A reduced AT number would then be derived, and may be regarded as a synapomorphy for the sitalcinoids. In most instances, a strongly reduced AT number correlates with small body size, as in all paedomorphic species, and seems to be an adaptive character. Exceptions to this trend is the AT reduction in some larger species (of *Enigmina*, *Megacina*, and *Banksula*). The scoring is: >6 pairs = State 0; 3-6 pairs = State 1; 2 pairs = State 2; 1 pair = State 3; none = State 4.

22.— Cuticle texture. In most phalangodids, including *Calicina* (Fig. 4b), the tubercles on the scute are randomly arranged (State 0) so that the more complex, areolate, arrangement is considered derived (State 1). This condition occurs in *Microcinella* (Figs. 7a-b), *Microcina* (Fig. 9a-d), *Tularina tularensis* (Figs. 38a-c), and the *Megacina madera* group (Figs. 45a-c, 47a-b, 49a-b). Given its presence in relatively basal sitalcinoid groups, it may well be a synapomorphy for the entire complex, with independent losses (character reversals to random state) occurring in *Sitalcina-Enigmina*, *Tularina plumosa* and *T. scopula*, and *Megacina cockerelli*.

Chelicerae.

23.— Boss. A pointed lateral process (boss), observed only in *Megacina cockerelli* (Figs. 51a-d) and *Banksula* (Fig. 5a), is considered derived (State 1).

Palpal femur.

24.—Setose dorsal tubercles. In most phalangodids the palpal femur bears a dorsomedian row of setae (State 0). In *Sitalcina lobata* (Figs. 31c-e) and *Banksula* (Figs. 5b-c), these setae are situated on tubercles and considered derived. The form of the tubercles differs in the two taxa, being low and rounded in *S. lobata* (State 1) and long and pointed in *Banksula* (State 2), and suggests independent origin.

25.—Asetose dorsal tubercles. Asetose tubercles, which are located between (and thus not homologous to) the standard dorsal setae, are known only from the *Sitalcina sura* group (e.g., Fig. 21b), and are clearly derived (State 1).

26.—Mesal tubercle. This is found only in the *Sitalcina sura* group (e.g., Fig. 21b) and represents a continuation of the dorsal asetose tubercle row (State 1).

Legs.

27.—Male trochanter IV (TrIV). In *Calicina*, *Microcinella*, and *Microcina* the TrIV is unmodified (e.g., Fig. 9e), so the presence of any structures is derived. Ventral tubercles (State 1) are found in *Tularina scopula* (Fig. 42f), *Megacina cockerelli* (Fig. 52f-j), *Banksula*, and *Texella bifurcata* (fig. 11 of Ubick and Briggs, 1992). Larger ventral processes (spurs, State 2) occur in other *Texella*, *Sitalcina* (Figs. 15g, 17f, 31g), and *Enigmina* (Figs. 35e-f). The shortest spurs are in *Enigmina*, medium-sized in *Sitalcina*, and largest in *Texella*.

28.—Femur IV. In the *Megacina madera* group, a ventrobasal projection on Fm IV (Figs. 45e-f, 47e-g, 49d-e) occurs in both sexes, although typically larger in males. As this modification is not found in other Nearctic phalangodids, it is clearly derived (State 1).

29.—Tarsal count. The tarsal count is 3-5-5-5 in *Calicina mariposa* and the majority of phalangodids, so both a tarsomere decrease (State 1) and increase (State 2) are derived. This modification is adaptive, with a TC reduction in paedomorphs and an increase in troglomorphs.

ANALYSIS.—We used MacClade (versions 2.1 and 4.08) for studying character transformations and branching patterns and PAUP* (versions 3.0 and 4.0b10) for finding the shortest trees. All trees discussed are also presented as branching diagrams in Fig. 56.

A heuristic search was run using the entire matrix (27 taxa, 29 characters), with characters unordered and unweighted, but was aborter after an hour, having already produces over 700 shortest trees of 77 steps.

For the second run, redundant taxa were removed from the matrix. The *Sitalcina sura* group was represented only by *S. sura* and *S. peacheyi*, *Enigmina* by *E. warrenorum*, and the *Megacina madera* group by *M. madera* and *M. schusteri*. A heuristic search of this reduced matrix produced three shortest trees of 74 steps (CI=0.57). The three trees are very similar and differ only in the branching within the clade composed of *Microcinella* (MI), *Microcina* (Mc), and *Tularina* (T). This clade groups with the one composed of *Sitalcina* (S) plus *Enigmina* (E), and the two together with *Megacina* (Mg) plus the bifurcate clade (BC), as:

[Tree 1] C (((MI+Mc+T) (S+E)) (Mg+BC)).

Two of the clades suggested by this tree appear reasonable, as they are each supported by genitalic and secondary sexual characters: Mg+BC by VP with dorsal setae (character 6) and S+E by large DL (10) and male TrIV spurs (27). However, the third clade, MI+Mc+T, seems to be supported only by adaptive characters [the reduction in tarsal count (29), eyes (20), and AT number (21)], and so appears to be less well justified (see also section below on Paedomorphy).

For the third run, we omitted these characters from the matrix and obtained 16 shortest trees of 61 steps (CI=0.57), which represent two basic topologies:

[Tree 2] C (MI+Mc+Ttp+(S (E (Ts (Mg+BC))))).

[Tree 3] C ((MI+Mc+Ttp+(S+E)) (Ts (Mg+BC))).

With the omission of the adaptive characters, MI+Mc+T no longer form clade, but remain unresolved and basal, either to all other sitalcinoids plus BC (tree 2) or in a clade with S+E (tree 3). Interestingly, in all trees, *T. scopula* (Ts) groups with Mg+BC, and not with other *Tularina* (Ttp). Although *T. scopula* does differ markedly from other *Tularina*, as detailed above in the Homology section, it is clearly congeneric on the basis of synapomorphies of both male and female genitalia, as the fused PSL (11) and the bifid OV setae (19), the latter shared with *T. plumosa*. Another problem with these trees is the position of *Microcinella* which, given its fundamentally different mode of glans expansion (character 1), is most likely the basal member of the "folding glans clade", as argued above. Accepting these constraints, with *Microcinella* basal and *Tularina* monophyletic, results in a tree that is only one step longer, 62 steps (CI=0.56):

[Tree 4] C (MI ((Mc (S+E)) (T) (Mg+BC))).

In this tree, the placement of T is ambiguous, as grouping with either (Mc(S+E)) or (Mg+BC) does not change the tree length. This study has failed to turn up any potential synapomorphies between T and (Mc(S+E)). However, one important genitalic character state, fused PSL (11), is found only in *Tularina* and the *Megacina madera* group and suggests a relationship between the two genera. Further support for this grouping is the presence of dorsolateral VP setae in *T. plumosa* which, as we have argued above, may represent the precursor state for the VP dorsal setae (6) found in *Megacina* and the bifurcate clade. Thus, the shortest tree that represents our basic assumptions is the following:

[Tree 5] C (MI ((Mc (S+E)) (T) (Mg+BC))).

BIOGEOGRAPHY

In previous studies of phalangodid biogeography, we examined the distributions of *Calicina*, *Banksula*, and *Texella* (Ubick and Briggs 1989, 1992, 2002) and described intricate groupings of largely allopatric species. Not surprisingly, similar patterns are found in the *Sitalcina* complex, which is primarily Californian, with extensions into SW Oregon and SE Arizona (Fig. 57). The species are fully allopatric within genera, with the single exception of sympatry between *Megacina cockerelli* and *M. mayacma*, species representing different species groups. The genera are also mostly allopatric, except in the central coast region (Fig. 58). Here *Sitalcina* is sympatric with *Megacina* in the north, with *Microcina* in the south, and with both in the central portion (Marin and Alameda counties). *Microcina* is also sympatric with *Microcinella* in Santa Clara County.

VICARIANCE.—The largely allopatric distributions in the *Sitalcina* complex suggest vicariance as the obvious mechanism. The barriers necessary to account for the current distributions would have been, most parsimoniously, between the ranges of the extant taxa, with the sequence of these barriers suggested by the cladogram (Fig. 56: T5). The first barrier would have been at the periphery of the distribution of *Microcinella*, separating it from the non-telescoping clade (which also includes the bifurcate clade). The second set of barriers, separating the clades (Mc (S+E)) from (T (Mg+BC)), would have required a coastal, Sierran, and Mojavian component. The Coast Range portion is now obscured by sympatry, but the Sierran portion is clear, being the boundary between E and T, and the Mojavian portion would have been at the eastern boundary of *S. lobata*, separating it from *Texella deserticola* (see Ubick and Briggs, 1992). A third set of barriers would have separated Mc from S+E and T from M+BC). Again, only the Sierran boundary is clear, being the disjunction between T and M. Finally, the fourth set of barriers would have been between S and E, currently a disjunction, and between M and BC. The bifurcate clade is almost entirely allopatric

with *Megacina* (see Ubick and Briggs, 1992, 2002). *Texella bifurcata* occurs in NW California, largely E of *Megacina cockerelli* and N of the *M. madera* group. The coastal range of *Banksula* is S of *Megacina cockerelli* and its Sierran range currently in the disjunction between *Megacina madera* and *M. schusteri*. Subsequent sets of barriers would have been necessary to separate the species groups (of *Sitalcina* and *Megacina*) and, ultimately, the species themselves.

DISPERSAL.— Although vicariance can explain most of sitalcinoid distribution, some dispersal is also necessary to account for the cases of sympatry. These are, at present, restricted to the greater San Francisco Bay area, which also happens to be the best sampled region. No doubt more sympatry can be expected with additional sampling.

The location of the vicariance barrier is obscured because of sympatry. However, if the direction of the dispersal and the dispersers could be identified, then a more precise location of the barriers would be possible. As relictual species persist through time, it seems parsimonious to assume that they also persist in space. With this assumption, the relatively basal groups would have priority for the territory (i.e., their current range coinciding more closely with the ancestral) and the more derived groups would then represent a dispersal into the range of the relict. Applying this reasoning to the above sympatries, it follows that: 1) *Microcina jungi* dispersed into the range of *Microcinella*, 2) *Sitalcina californica* into that of *Microcina*, and 3) *Megacina cockerelli* into that of *Microcina* (in Marin County). Less clear is the sympatry between *M. cockerelli* and *S. californica*, as both are clearly derived elements. However, given that the former is the most derived branch of the *Tularina-Megacina* clade and the latter the least derived of *Sitalcina-Enigmina*, suggests that of the two, *S. californica* is relatively more plesiomorphic and that *M. cockerelli* is the disperser. Finally, in the sympatry between *M. cockerelli* and *M. mayacma*, the former (being more derived) would then have dispersed into the range of *M. mayacma*.

Although this is the minimum dispersal necessary to account for the known sitalcinoid distributions, clearly much more is necessary to take into account the remaining phalangodids in California. The bifurcate clade intrudes into the sitalcinoid range most sharply with *Banksula incredula*, the presumed basal member of the clade, where it is sympatric with both *Sitalcina* and *Microcina*. The remaining bifurcate members, *Texella* and other *Banksula* are closely parapatric with the sitalcinoids, with known instances of sympatry only in the extreme northwest (between *Texella bifurcata* and *Megacina cockerelli*) and south (between *Texella deserticola* and *Sitalcina lobata*). Adding the distribution of *Calicina* into the analysis (Ubick and Briggs 1989) dramatically increases the amount of dispersal needed to account for all Californian Phalangodidae.

PAEDOMORPHY.— Species of sitalcinoids (Figs. 57, 59) occur in either grassland or forest habitats, and very rarely in both. At the generic level they divide evenly, with *Microcinella*, *Microcina*, and *Tularina* known almost exclusively from grasslands, and *Sitalcina*, *Enigmina*, and *Megacina* from forests. The grassland species occur in two disjunct regions, the San Francisco Bay area and central Tulare County, and occupy a much smaller total distribution than do the forest dwellers.

As has been previously observed (Briggs, 1968), grassland species differ from forest dwellers morphologically, being small, blind, and having reduced structures. The mechanism of paedomorphy was proposed to account for this situation, specifically progenesis: the reduction in body size and structure resulting from a shortened life cycle (Ubick and Briggs, 1989). These are obvious adaptations to the grassland environment, which is relatively xeric and provides a shorter growing season. Blindness suggests a prolonged subterranean existence, such as found in cave species (Briggs and Ubick 1989; Ubick and Briggs 1989).

As paedomorphy is a derived condition, these characters might be viewed as synapomorphies for the grassland sitalcinoids. However, our interpretation of genitalic characters places these gen-

era relatively basal, with *Microcinella* the most plesiomorphic member of the folding glans clade, *Microcina* basal to *Sitalcina* and *Enigmina*, and *Tularina* basal to *Megacina* and the bifurcate clade. Alternately, the theoretical possibility that paedomorphy is derived for the sitalcinoids and then lost in the forest taxa, also does not seem likely as these adaptations would seem to operate within relatively short time frames and not persist through phylogenetic time. Indeed, in *Calicina*, paedomorphic taxa appear to have been independently derived in several lineages (Ubick and Briggs 1989), as are troglomorphic taxa in *Texella* (Ubick and Briggs 1992). The plausible conclusion, then, is that paedomorphy evolved independently in the three sitalcinoid genera, in relatively recent time, and that all sitalcinoids were originally non-paedomorphic forest dwellers.

As to a possible origin of paedomorphy, the simplest hypothesis may be that it arose in response to an environmental shift towards more xeric conditions; in other words, the grasslands and paedomorphics evolved synchronically. In sitalcinoids, *Tularina* may represent this mode, given that the species currently reside in grasslands that are typically well isolated from forests. By contrast, most *Microcina* and *Microcinella* occur in grasslands that have adjacent forests, with some species even occupying grassland-forest ecotones. Here, an alternate hypothesis is possible, that these species migrated from the forest and onto pre-existing grassland, there to become paedomorphic. This possibility is further suggested by the presence of forest-dwelling sitalcinoids in close proximity to *Microcina*, *Sitalcina californica* occurring throughout its range and *Megacina cockerelli* in the north. As the forest species are clearly more successful than the grassland ones, being larger organisms, more widely distributed, and (based on our collection records) far more abundant, it is certainly plausible that they negatively impacted *Microcina*, perhaps even displacing it to a less favorable habitat.

FUTURE STUDY

Although this study greatly increases our knowledge of sitalcinoid harvestmen, much work still remains for a full description of the fauna. Due to time constraints, it has not been possible adequately to analyze some of the material on hand. The morphological variation in *Megacina cockerelli*, and to a lesser extent in *Sitalcina californica*, needs to be more carefully examined for the presence of additional species. Also, the male genitalia of some *Sitalcina* need to be more fully described, especially the form of the often hidden stylus. However, some existing gaps will only be filled through study of additional specimens, such as the status of the currently recognized species in Arizona, the unknown male of *S. borregoensis*, and the known but currently undescribed species of *Microcina* and *Sitalcina*. But the most interesting and potentially surprising information is likely to come from the discovery of new species and populations. These are most probable in the larger disjunctions between the known distributions, and especially in the disjunctions between genera (*Tularina* and *Megacina*, *Sitalcina* and *Enigmina*). Their discovery would not only increase the net knowledge based on these organisms but, more importantly, test the relationships proposed.

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Barr (UCB), Lynn Kimsey and Steve Hayden (UCD), Richard Vetter (UCR), William Shear (CWS), and James C. Cokendolpher (CJC). Special appreciation goes to Wendell Icenogle and Robert Pape for their donation of important specimens. Appreciation is extended to Charles E. Griswold and the Entomology Department at CAS for generous use of facilities, Tony Walecka, Larry Arndt, Favio Penny, and others in Computer Services for solving many computer puzzles and especially their magical powers in restoring the dead (computers). Hilbert Tu very generously donated a copy of Adobe Illustrator to help produce the maps. Suzanne Ubick graciously edited various versions of this manuscript and provided assistance and companionship throughout. Charles Griswold and William Shear critically reviewed earlier versions of the manuscript and provided many helpful comments.

LITERATURE CITED

- BANKS, N. 1893. The Phalangida Mecostethi of the United States. *Transactions of the American Entomological Society* 20:149–152.
- BANKS, N. 1901. Synopses of North-American invertebrates. XVI. The Phalangida. *American Naturalist* 35(416):669–679.
- BANKS, N. 1904. Some Arachnida from California. *Proceedings of the California Academy of Sciences*, ser. 3, 3(13):331–377.
- BANKS, N. 1909. Arachnida from Costa Rica. *Proceedings of the Academy of Natural Sciences of Philadelphia* 61:194–234.
- BANKS, N. 1911. The Phalangida of California. *Pomona College Journal of Entomology*, Claremont 3:412–421.
- BRIGGS, T.S. 1967. An emendation for *Zuma acuta* Goodnight and Goodnight (Opiliones). *The Pan-Pacific Entomologist* 43:89.
- BRIGGS, T.S. 1968. Phalangids of the laniatorid genus *Sitalcina* (Phalangodidae: Opiliones). *Proceedings of the California Academy of Sciences*, ser. 4, 36:1–32.
- BRIGGS, T.S., AND K. HOM. 1966. Five new species of Phalangodidae from California (Opiliones). *The Pan-Pacific Entomologist* 42(4):262–269.
- BRIGGS, T.S., AND K. HOM. 1967. New Phalangodidae from the Sierra Nevada Mountains (Opiliones). *The Pan-Pacific Entomologist* 43(1):48–52.
- BRIGGS, T.S., AND D. UBICK. 1989. The harvestman family Phalangodidae. 2. The new genus *Microcina* (Opiliones: Laniatores). *Journal of Arachnology* 17:207–220.
- EDGAR, A.L. 1990. Opiliones (Phalangida). Pages 529–581 in D.L. Dindal, ed., *Soil Biology Guide*. John Wiley and Sons, New York, USA. 1349 pp.
- GOODNIGHT, C.J., AND M.L. GOODNIGHT. 1942. New Phalangodidae (Phalangida) from the United States. *American Museum Novitates* (1188):1–18.
- KURY, A.B. 2003. Annotated catalogue of the Laniatores of the New World (Arachnida, Opiliones). *Revista Ibérica de Aracnología* 1:1–337.
- LUCAS, H. 1860. Observations sur un genre nouveau d'Arachnide trachéene (*Scotolemon lespesii*). *Annales de la Société Entomologique de France*, ser. 3, 8:973–983.
- MARTENS, J. 1972. *Ausobskya athos*, der erste Krallenweberknecht aus Griechenland (Opiliones: Phalangodidae). *Senckenbergiana biologica* 53(5/6):431–440.
- RAMBLA, M. 1969. Cave harvestmen from Jamaica (Opiliones: Phalangodidae). *Psyche* 76:390–406.
- ROEWER, C.F. 1912. Die Familien der Assamiiden und Phalangodiden der Opiliones-Laniatores. *Archiv für Naturgeschichte, Berlin* 78 A(3):1–242.
- ROEWER, C.F. 1923. *Die Weberknechte der Erde. Systematische Bearbeitung der bisher bekannten Opiliones*. Gustav Fischer, Jena, Germany. 1116 pp.
- UBICK, D. 2007. Phalangodidae Simon, 1879. Pages 217–221 in R. Pinto-da-Rocha, G. Machado, and G. Giribet, eds., *Harvestmen: The Biology of Opiliones*. Harvard University Press, Cambridge, Massachusetts, USA. 597 pp.

- UBICK, D., AND T.S. BRIGGS. 1989. The harvestmen family Phalangodidae. 1. The new genus *Calicina*, with notes on *Sitalcina* (Opiliones: Laniatores). *Proceedings of the California Academy of Sciences*, ser. 4, 46:95–136.
- UBICK, D., AND T.S. BRIGGS. 1992. The harvestman family Phalangodidae. 3. Revision of *Texella* Goodnight and Goodnight (Opiliones: Laniatores). *Texas Memorial Museum, Speleological Monographs* 3:155–240.
- UBICK, D., AND T.S. BRIGGS. 2002. The harvestman family Phalangodidae. 4. A review of the genus *Banksula* (Opiliones: Laniatores). *Journal of Arachnology* 30:435–451.

Illustrations**Figures 2–58**

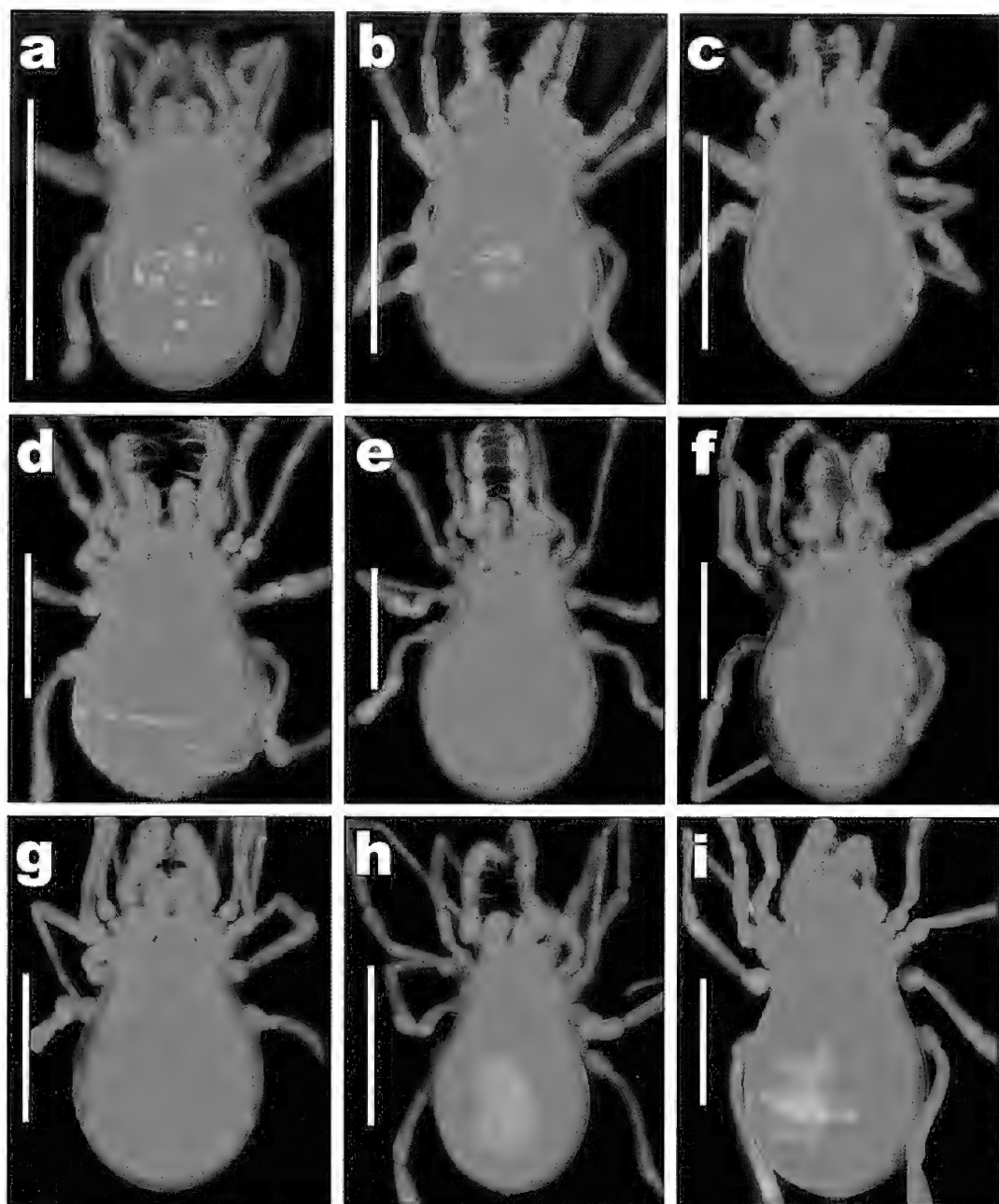


FIGURE 2. *Sitalcina* complex, females, dorsal view: a. *Microcinella homi* (Briggs and Ubick), b. *Microcina tiburona* (Briggs and Hom), c. *Tularina tularensis* sp. nov. d. *Sitalcina californica* (Banks), e. *S. sura* Briggs, f. *S. lobata* Goodnight and Goodnight, g. *Enigmina granita* (Briggs), h. *Megacina mayacma* sp. nov. i. *Megacina cockerelli* (Goodnight and Goodnight). Scale bar = 1mm.

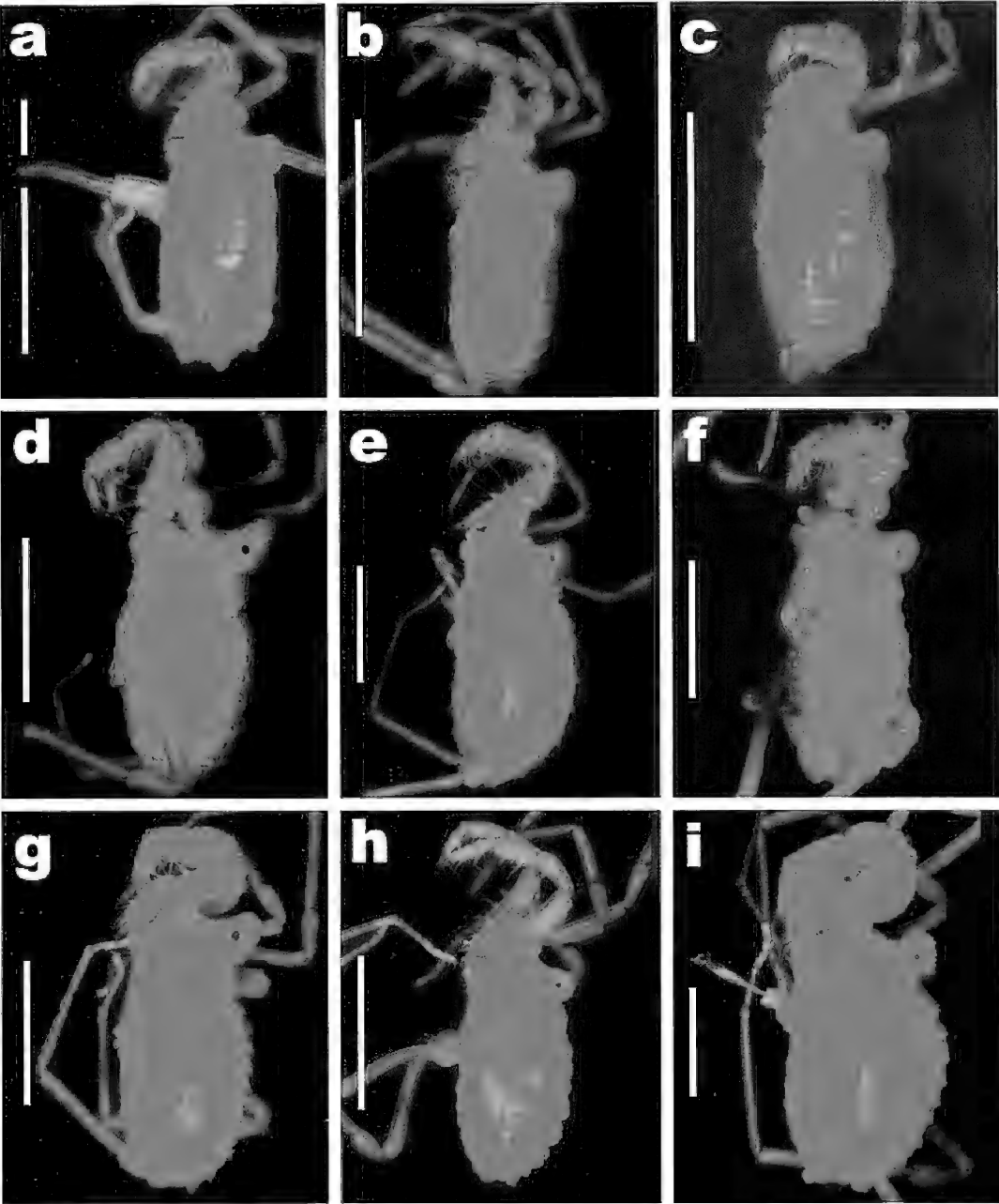


FIGURE 3. *Sitalcina* complex, males, lateral view: a. *Microcinella homi* (Briggs and Ubick). b. *Microcina tiburona* (Briggs and Hom). c. *Tularina nularensis* sp. nov. d. *Sitalcina californica* (Banks). e. *S. sura* Briggs. f. *S. lobata* Goodnight and Goodnight. g. *Enigmina granita* (Briggs). h. *Megacina mayucma* sp. nov. i. *Megacina cockerelli* (Goodnight and Goodnight). Scale bar = 1mm.

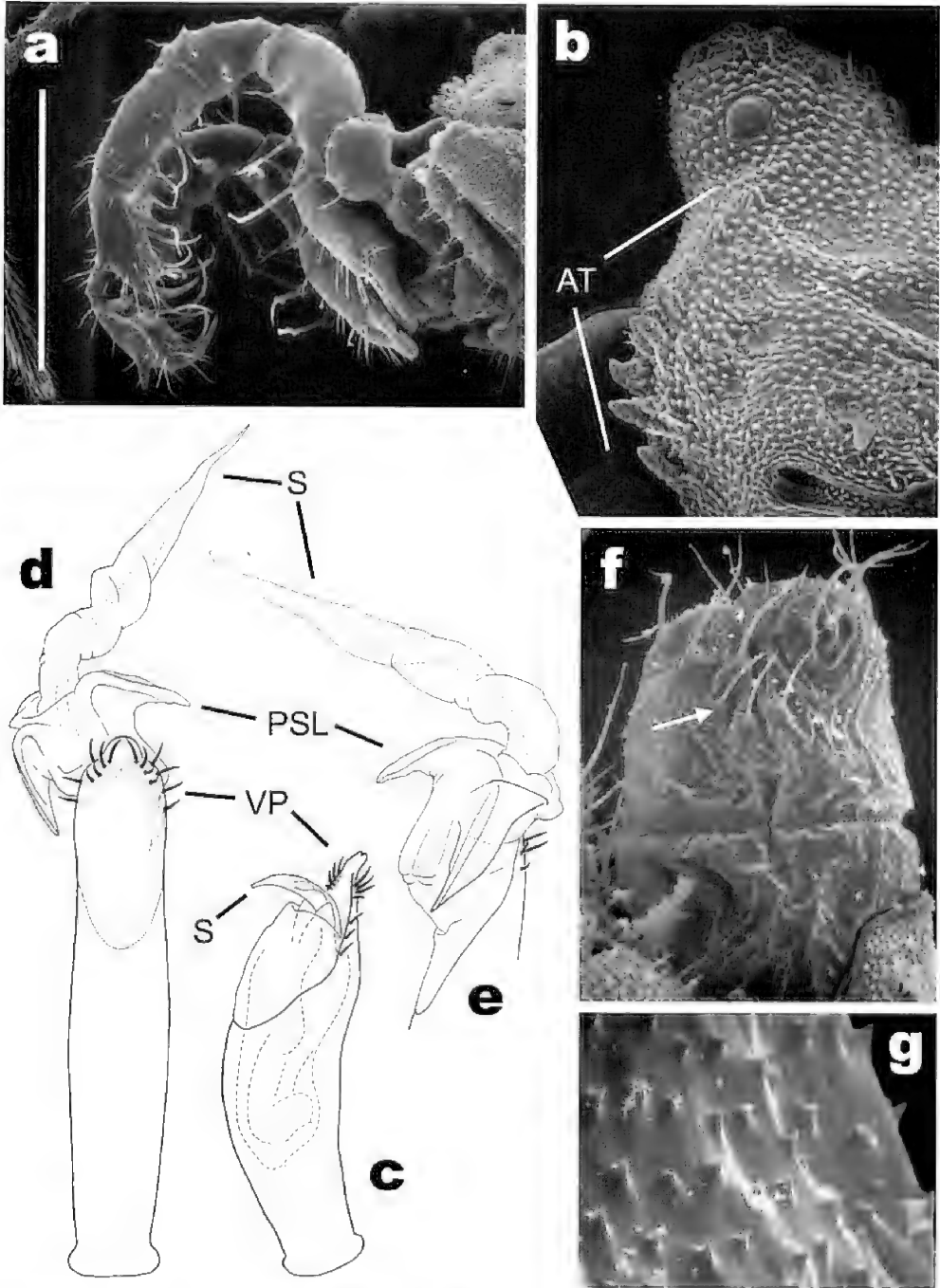


FIGURE 4. *Calicina* Ubick and Briggs, morphology. *C. mariposa* (Briggs) (a–b, d–g), *C. yosemitensis* (Briggs) (c). **a–c. Male.** a. Palpi, lateroventral view. b. Cephalon, lateral view, showing row of anterior tubercles (AT). c–e. Penis, unexpanded glans in dexterolateral view (c), and expanded glans in ventral (d) and dexterolateral (e) views. **f–g. Female.** ovipositor in dexterolateral view (f) showing subapical setae (arrow) and lateral surface with microspines (g). AT = anterior tubercles, PSL = parastylar lobes, S = stylus, VP = ventral plate. Scale bar = 475µm (a), 435µm (d, e), 350µm (c), 200µm (b), 195µm (f), 20µm (g).

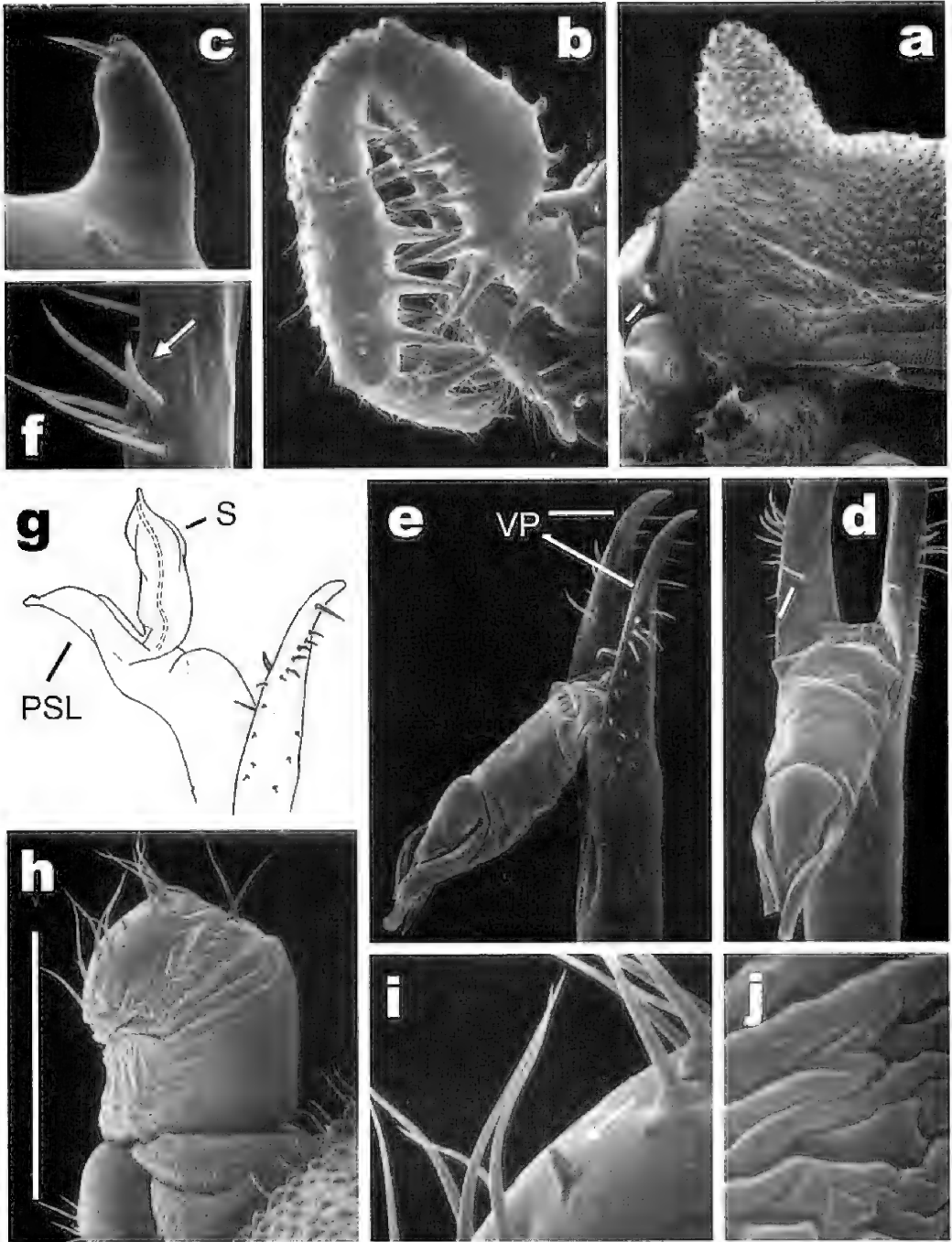


FIGURE 5. *Banksia incredula* Ubick and Briggs, morphology: **a-g. Male.** a. Cephalon, lateral view, with line showing cheliceral boss. b-c. Palpi, lateral view, showing setose dorsal femoral tubercle (c). d-g. Penis, with partially expanded glans in dorsal (d, f) and dexterolateral (e) views, showing AS (arrow) and dorsal seta (line), and fully expanded glans in dexterolateral view (g). **h-j. Female,** ovipositor, sinistrolateral view (h), with close-up showing apical tooth (i, arrow) and lateral surface lacking microspines (j). PSL = parastylar lobe, S = stylus, VP = ventral plate. Scale bar = 1.1mm (b), 880μm (a), 445μm (h), 310μm (g), 200μm (d-e), 120μm (i), 117μm (c), 86μm (f), 33μm (j).

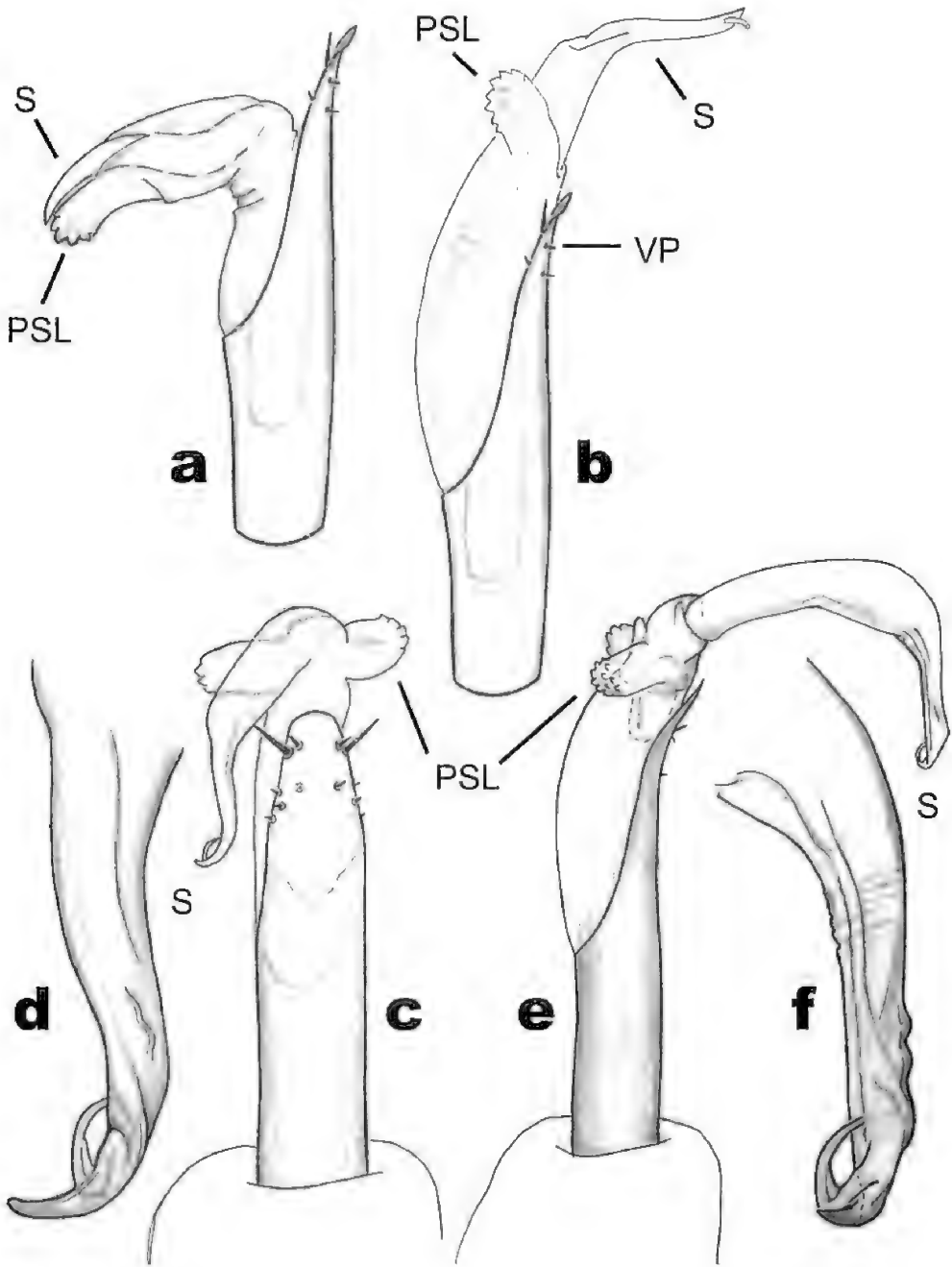


FIGURE 6. *Microcinella* gen. nov., male genitalia. a-b. *M. homi* (Briggs and Ubick) penis, dexterolateral view, with glans partially (a) and fully (b) expanded. c-f. *M. coensis* sp. nov. penis, fully expanded, in ventral (c-d) and dexterolateral (e-f) views. PSL = parastylar lobe, S = stylus, VP = ventral plate.

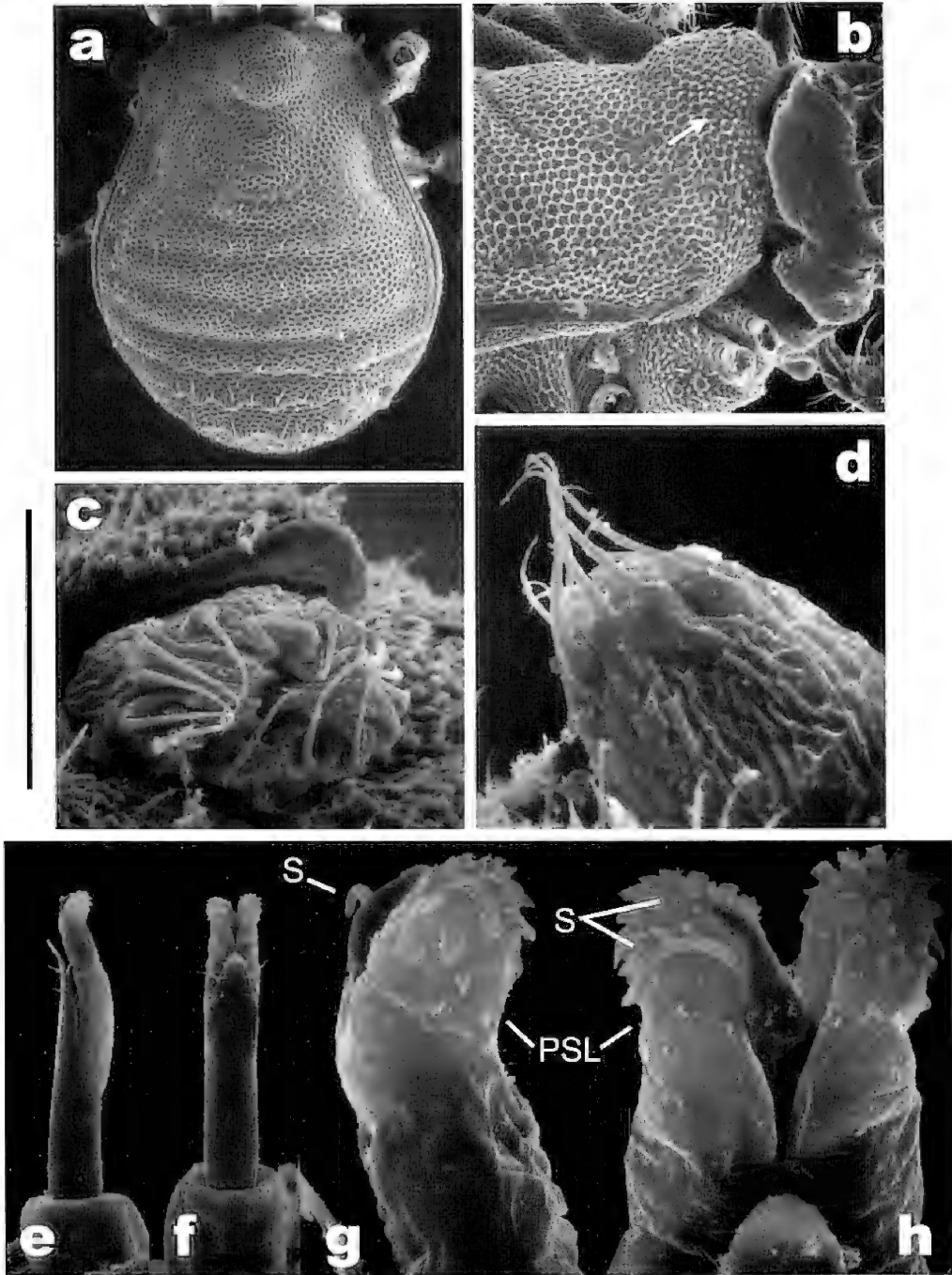


FIGURE 7. *Microcinella homi* (Briggs and Ubick), morphology. a-b. Male. c-d. Female. a-b. Body, dorsal (a) and lateral (b) views, with arrow showing corneal vestige. c-d. Ovipositor, apical (c) and dexterolateral (d) views. e-h. Penis with partially expanded glans (unfolded but not telescoped) in sinistrolateral (e) and ventral (f) views with close-up of glans (g-h). PSL = parastylar lobe, S = stylus. Scale bar = 480 μ m (a), 475 μ m (g-h), 290 μ m (e-f), 286 μ m (b), 82 μ m (c), 57 μ m (d).

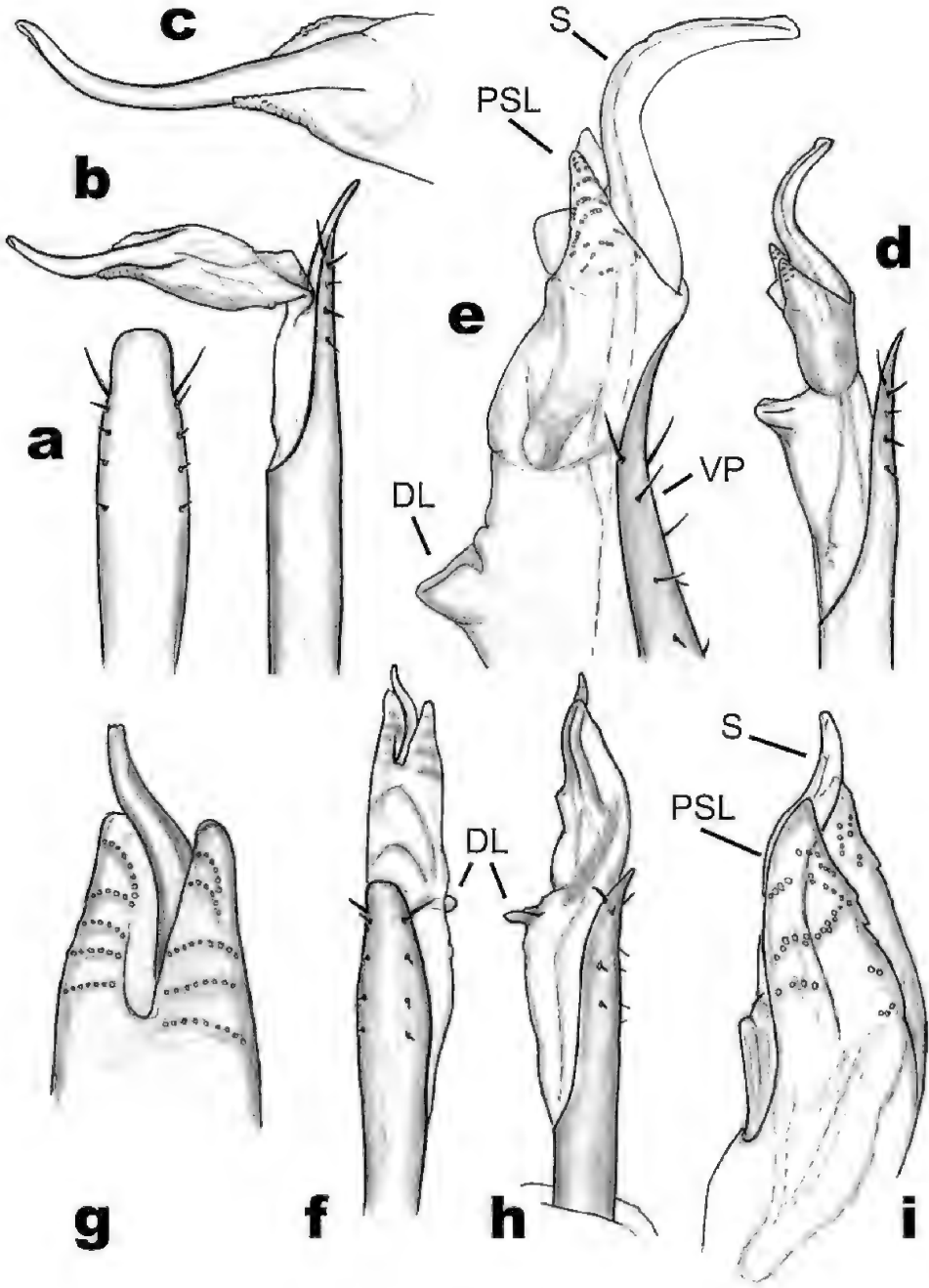


FIGURE 8. *Microcina* Briggs and Ubick, male genitalia. a–e. *M. tamalpais* sp. nov. penis, in ventral (a) and dexterolateral (b–c) views, showing glans partially (b–c) and fully (d–e) expanded, with close-ups (c, e). f–i. *M. potrero* sp. nov. penis, fully expanded, in sub-ventral (f–g) and dexterolateral (h–i) views, with close-ups of glans (g, i). DL = dorsal lobe, PSL = parastylar lobe, S = stylus, VP = ventral plate.

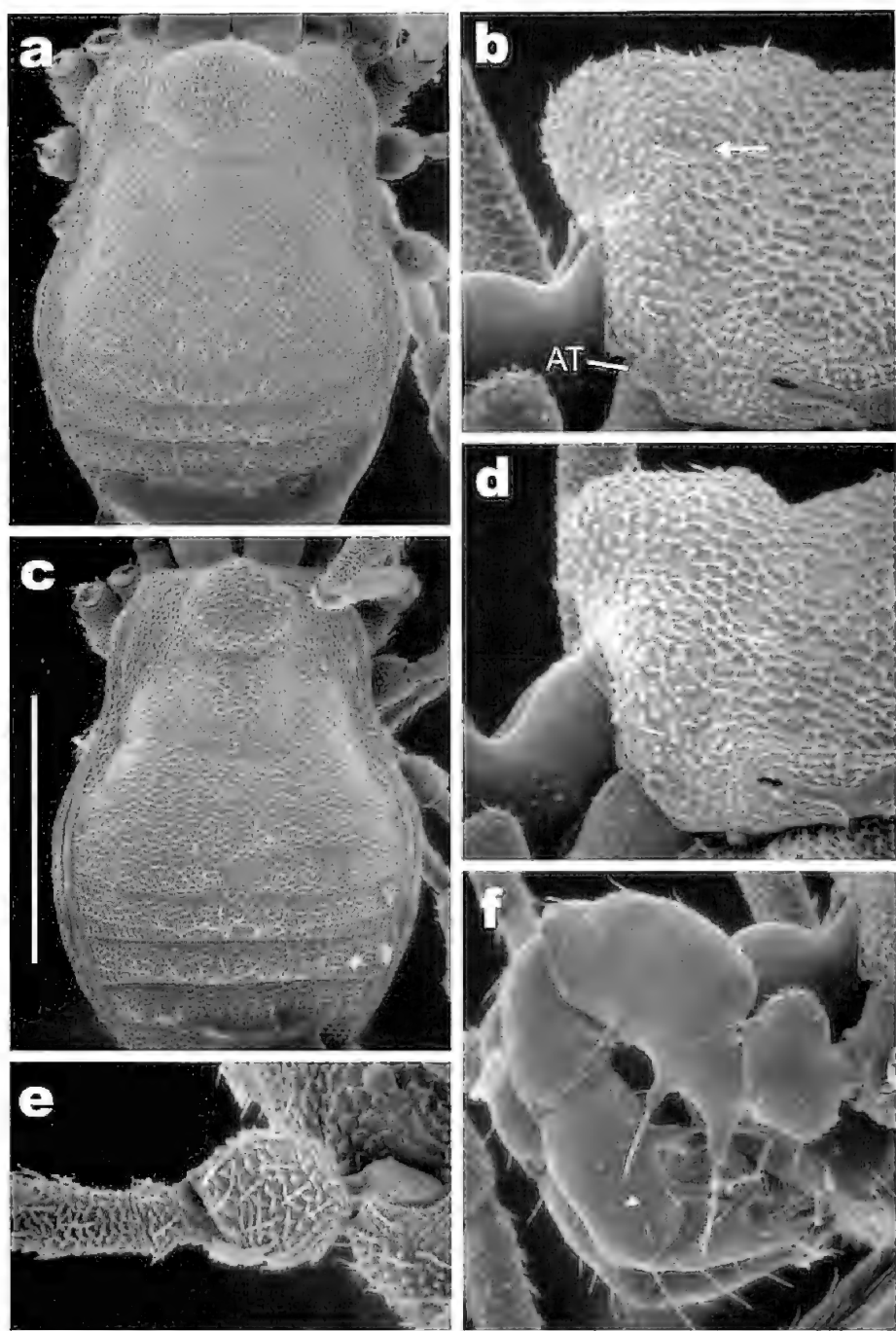


FIGURE 9. *Microcina sanbruno* sp. nov., somatic morphology. a–b, e–f. Male. c–d. Female. a, c. Body, dorsal view. b, d. Cephalon, lateral view, with arrow showing corneal vestige. e. Trochanter IV, lateral view. f. Palpi, lateral view. AT = anterior tubercle. Scale bar = 435 μ m (a, c), 250 μ m (f), 175 μ m (b, d), 167 μ m (e).

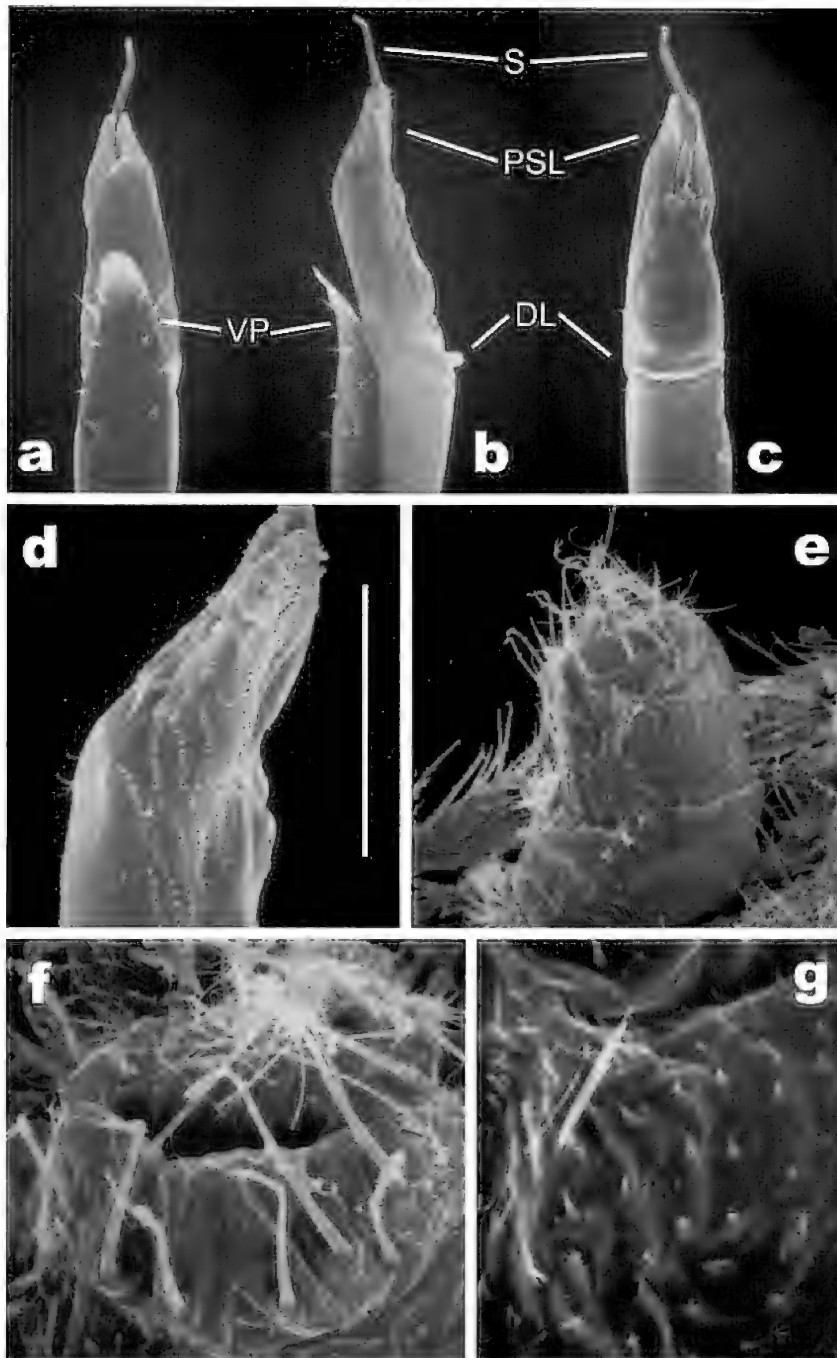


FIGURE 10. *Microcina sanbruno* sp. nov., genitalic morphology. a–d. Male, penis fully expanded in ventral (a), sinistrolateral (b, d), and dorsal (c) views, with close-up of glans (d). e–g. Female, ovipositor in sinistrolateral (e) and apical (f) views, with lateral surface showing microspines (g). DL = dorsal lobe, PSL = parastylar lobe, S = stylus, VP = ventral plate. Scale bar = 545 μ m (f), 455 μ m (d), 130 μ m (a–c, e), 26 μ m (g).

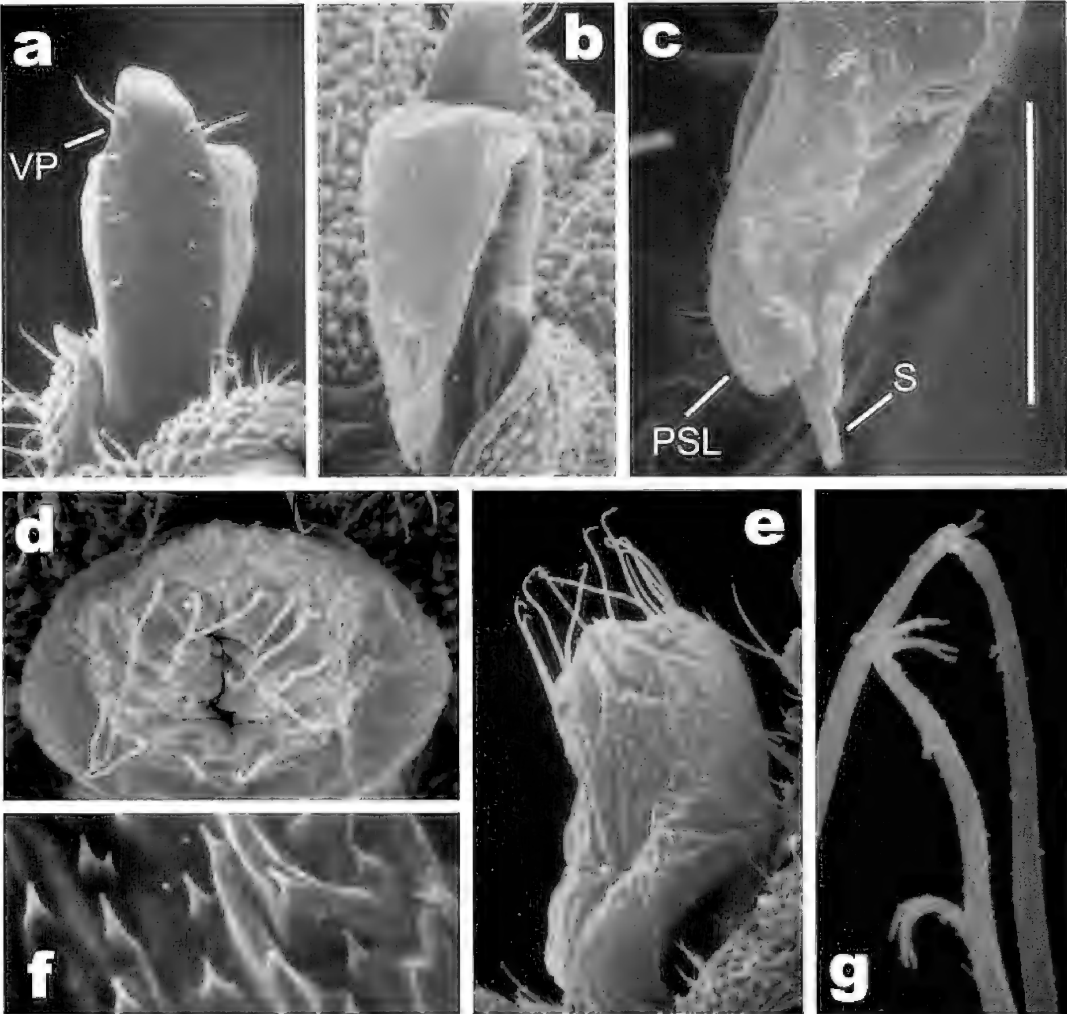


FIGURE 11. *Microcina stanford* sp. nov., genitalic morphology. a–c. Male, penis unexpanded in ventral (a) and subdorsal (b) views, with glans apex in dexterolateral view (c). d–g. Female, ovipositor in apical (d) and sinistrolateral (e–g) views, with close-up of lateral surface showing microspines (f) and of apical setae (g). PSL = parastylar lobe, S = stylus, VP = ventral plate. Scale bar = 143 μ m (e), 115 μ m (a–b, d), 38 μ m (c), 30 μ m (g), 19 μ m (f).

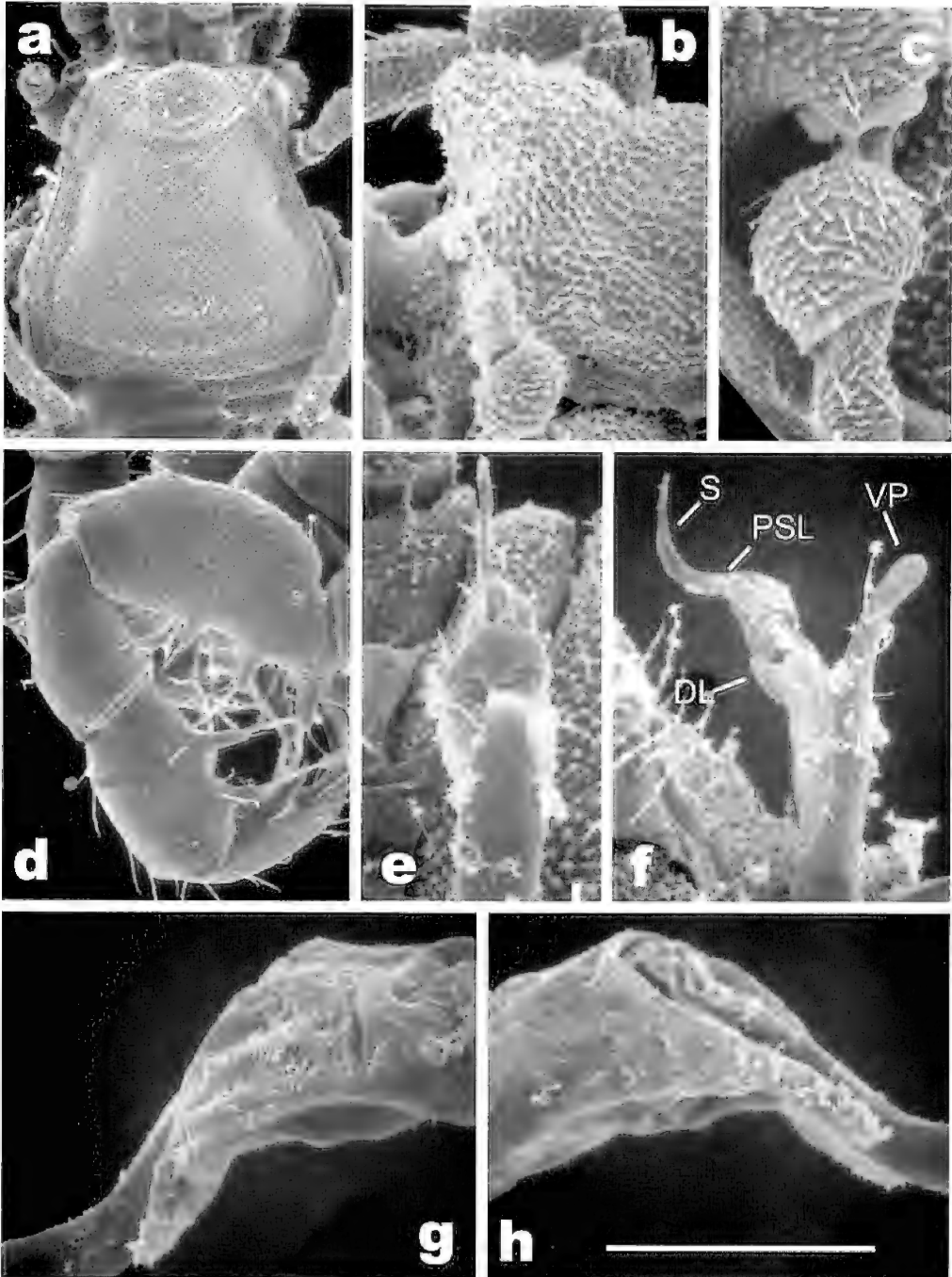


FIGURE 12. *Microcina tamalpais* sp. nov., male. a–d. Somatic morphology. a–b. Body dorsal (a) and cephalon lateral (b) views. c. Right trochanter IV, lateral view. d. Left palp, lateral view. e–h. Genital morphology. e–h. Penis, fully expanded in ventral (e) and dexterolateral (f) views, with glans apex in dexterolateral (g) and sinistrolateral (h) views. DL = dorsal lobe, PSL = parastylar lobe, S = stylus, VP = ventral plate. Scale bar = 475µm (a), 200µm (d), 190µm (b), 150µm (e–f), 30µm (g), 116µm (c), 38µm (g–h).

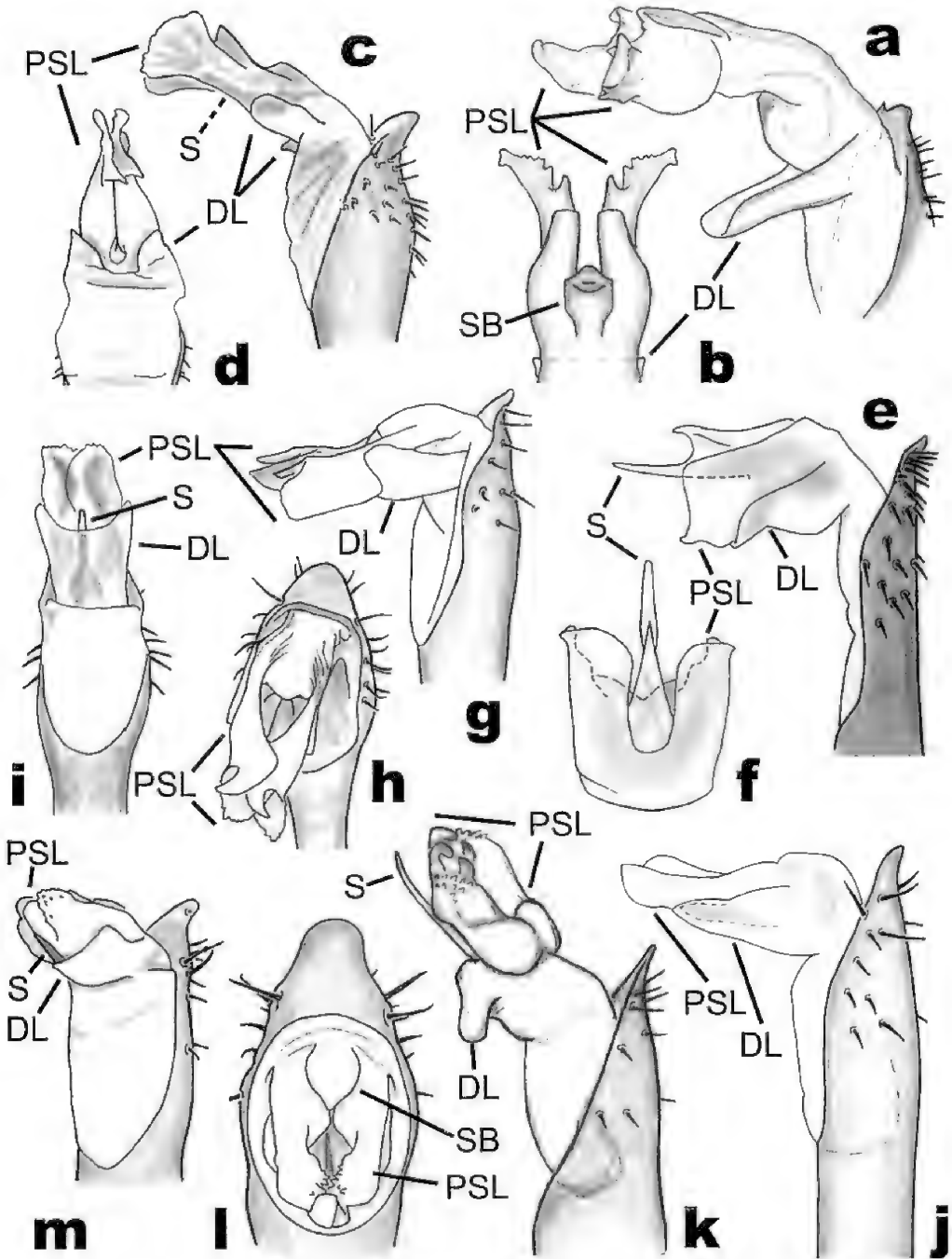


FIGURE 13. *Sitalcina sura* group, male genitalia. a-b. *S. sura* Briggs, fully expanded penis in dexterolateral view (a) and glans in ventral view (b). c-d. *S. seca* sp. nov., fully expanded penis in dexterolateral (c) and dorsal (d) views. e-f. *S. chalona* Briggs, partially expanded penis in dexterolateral view (e) and glans in ventral view (f). g-i. *S. flava* Briggs, partially expanded penis in dexterolateral (g) and subdorsal (h) views and fully expanded penis in dorsal view (i). j. *S. rothi* sp. nov., partially expanded penis in dexterolateral view. k-m. *S. peacheyi* sp. nov., penis, unexpanded in dorsal view (l), partially expanded in dorsolateral view (m), and fully expanded in dexterolateral view (k). DL = dorsal lobe, PSL = parastylar lobe, S = stylus, SB = stylar base, VP = ventral plate.

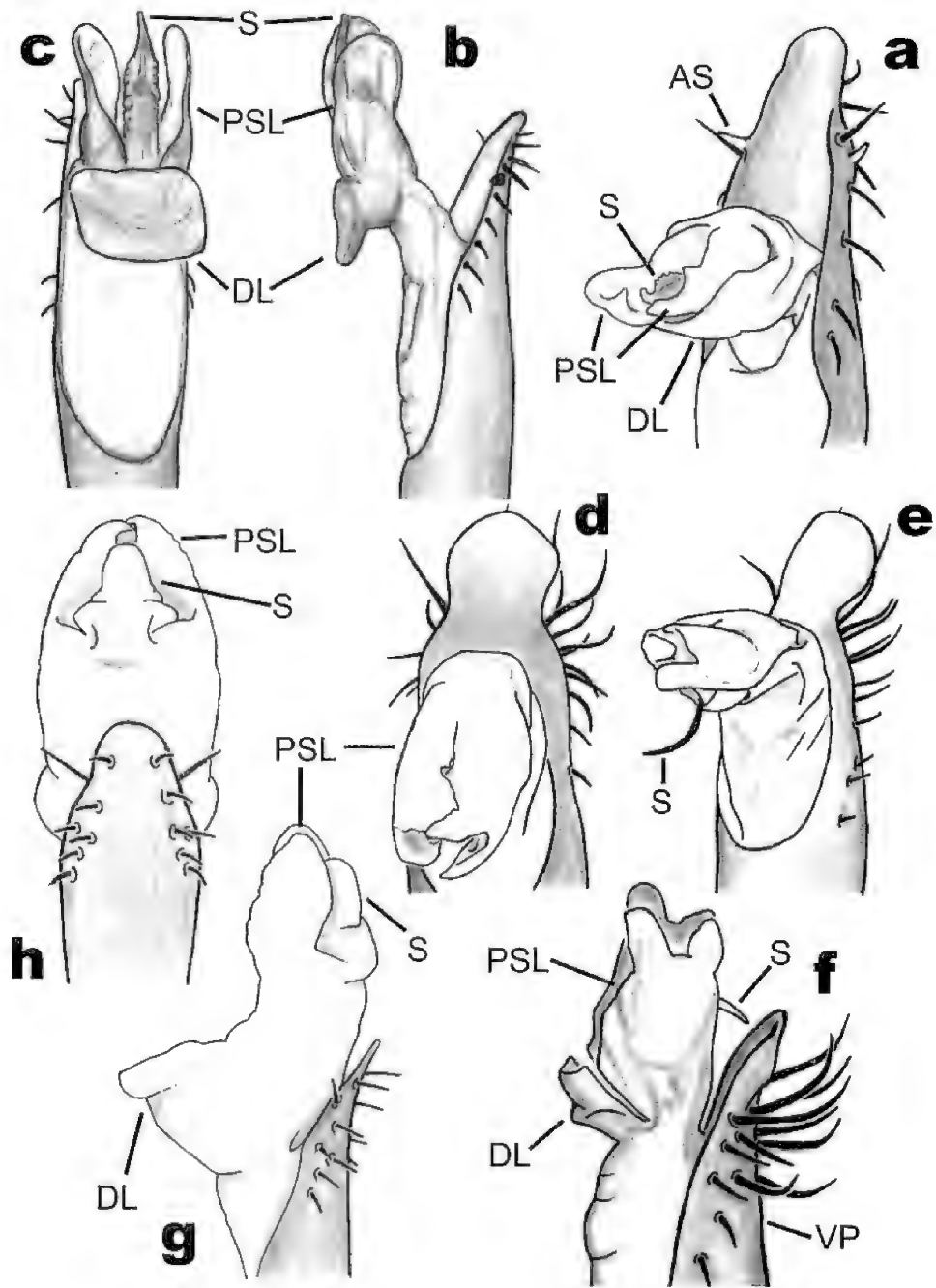


FIGURE 14. *Sitalcina californica* and *lobata* groups and *Enigmima* gen. nov., male genitalia. a–c. *S. californica* (Banks), penis with partially expanded glans in dorsolateral view (a) and with fully expanded glans in dexterolateral (b) and dorsal (c) views. d–f. *S. lobata* Goodnight and Goodnight, penis with glans folded in dorsal view (d), partially expanded in dorsolateral view (e), and fully expanded in dexterolateral view (f). g–h. *E. warrenorum* sp. nov., penis fully expanded in dexterolateral (g) and ventral (h) views. AS = apical spine, DL = dorsal lobe, PSL = parastylar lobe, S = stylus, VP = ventral plate.

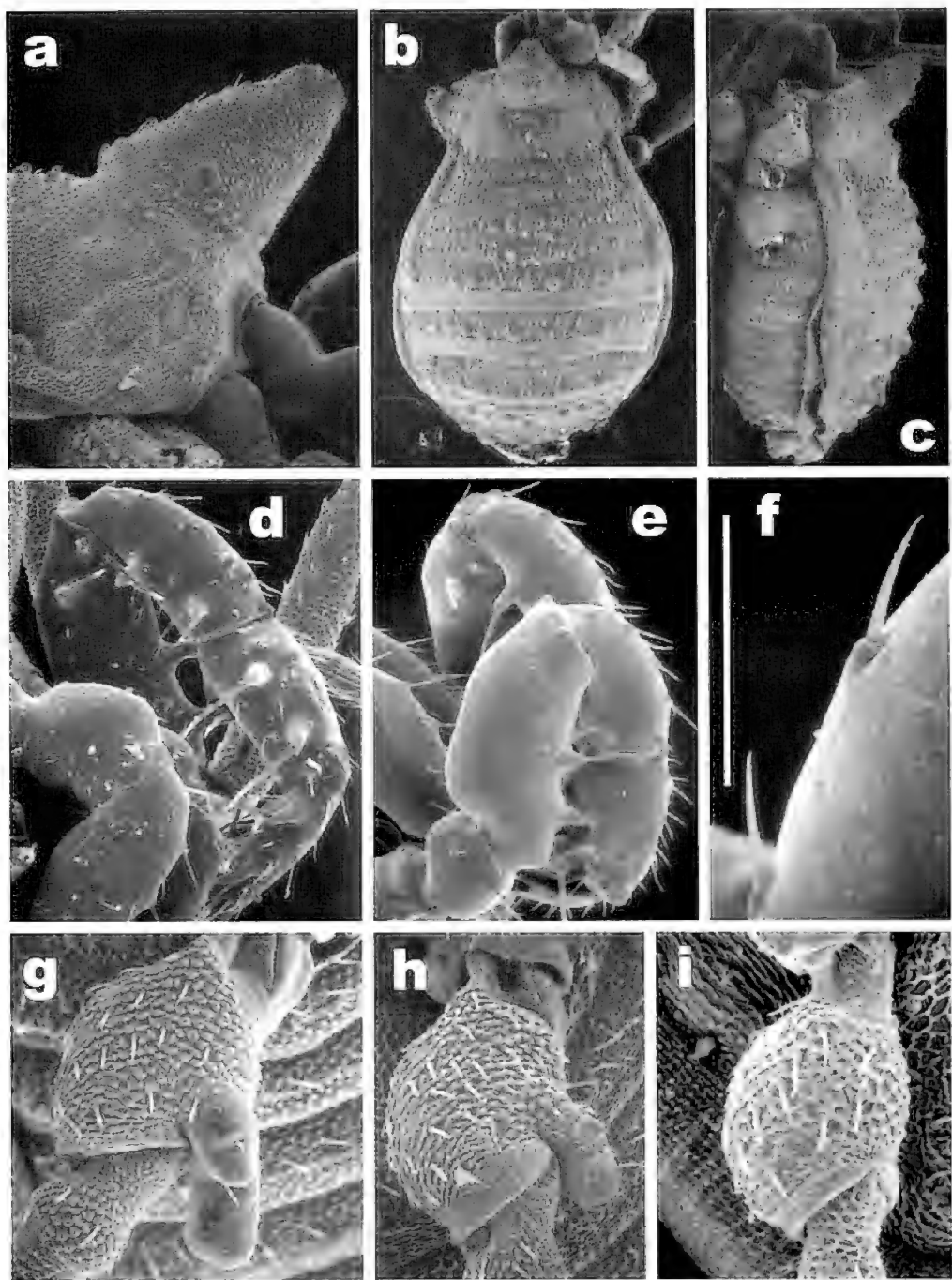


FIGURE 15. *Sitalcina californica* (Banks), somatic morphology. a, d-h. Male. b-c, i. Female. a-c. Body. a. Cephalon of male, lateral view. b-c. Body of female, dorsal and lateral views. d-f. Palpi of male, mesal (d) and ectal (e) views and femur dorsum showing setae (f). g-i. Trochanter IV of male (g-h) and female (i), ectal views. Scale bar = 1mm (b-c), 475 μ m (a), 380 μ m (d-e), 286 μ m (g-h), 200 μ m (i), 60 μ m (f).

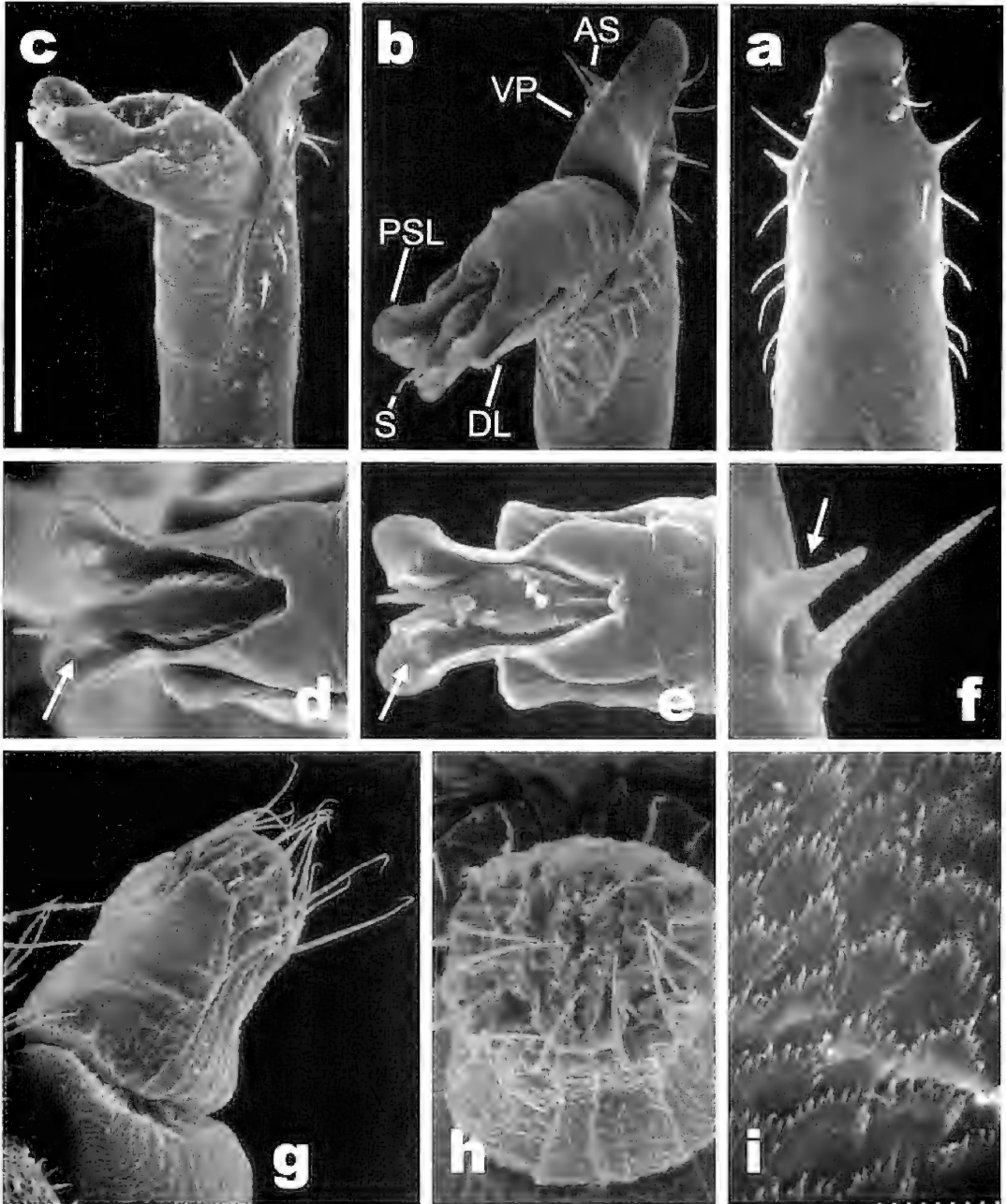


FIGURE 16. *Sitalcina californica* (Banks), genitalic morphology. a–f. Male, penis in ventral (a) and dexterolateral (b–c) views with glans partially (b) and more fully expanded (c), and glans, ventral view, of specimens from Cave Gulch (d) and El Verano (e), showing variation in PSL apicoventral ornamentation (arrows), and (f) lateroapical margin of VP showing apical spine (arrow). g–i. Female, ovipositor in dexterolateral (g) and apical (h) views, and lateral surface showing microspines (i). AS = apical spine, DL = dorsal lobe, PSL = parastylar lobe, S = stylus, VP = ventral plate. Scale bar = 190 μ m (g), 143 μ m (b–c), 126 μ m (h), 114 μ m (a), 82 μ m (d–e), 30 μ m (f), 19 μ m (i).

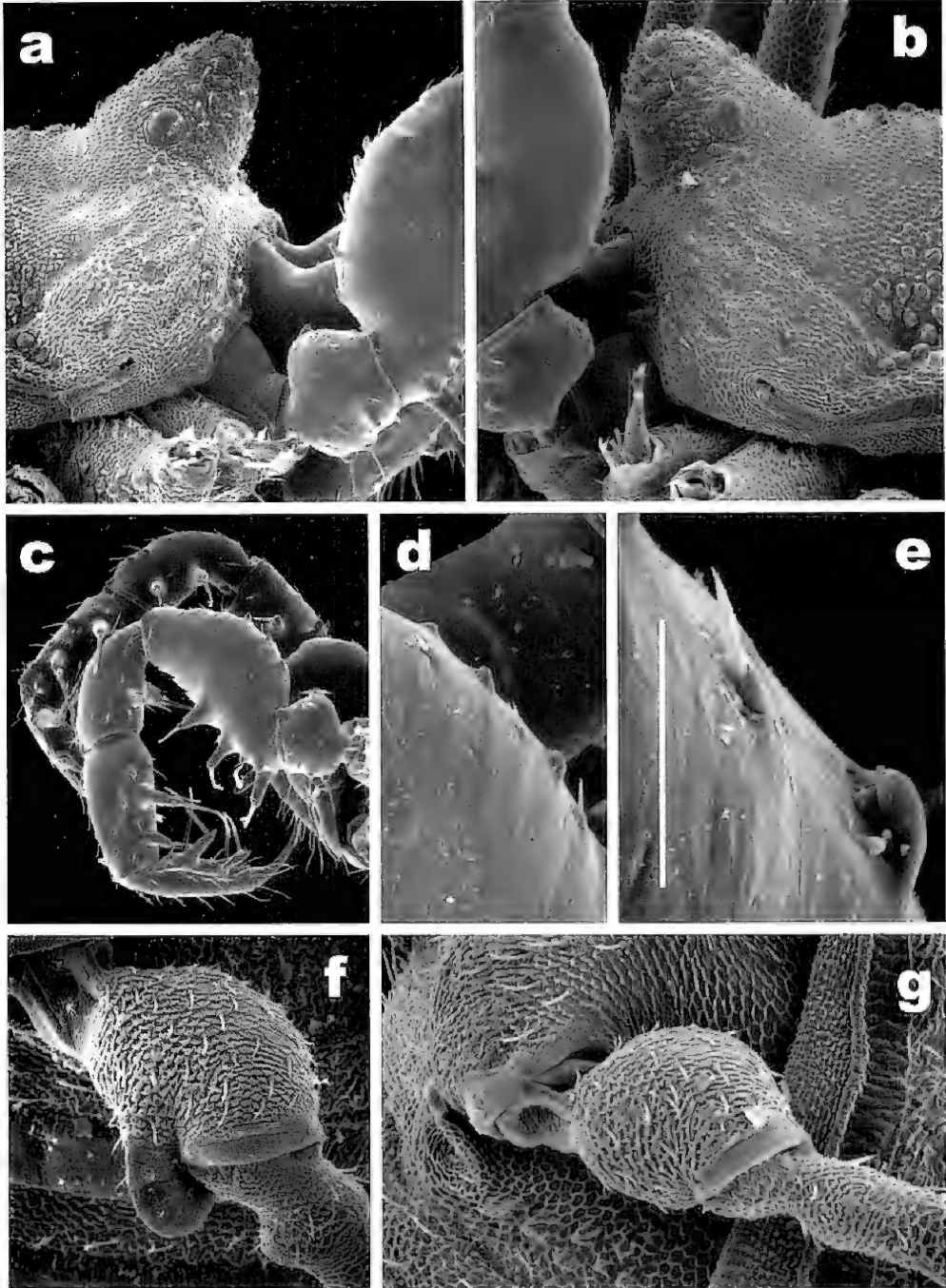


FIGURE 17. *Sitalcina sura* Briggs, somatic morphology. a, c, f. Male. b, d–e, g. Female. a–b. Cephalon, lateral view. c–e. Palpi, lateral view (c), with dorsolateral view of femur dorsum (d–e), showing dorsal setae and asetose tubercles. f–g. Trochanter IV, ectal view. Scale bar = 825 μ m (c), 490 μ m (a), 385 μ m (b), 320 μ m (f), 250 μ m (g), 130 μ m (d), 39 μ m (e).

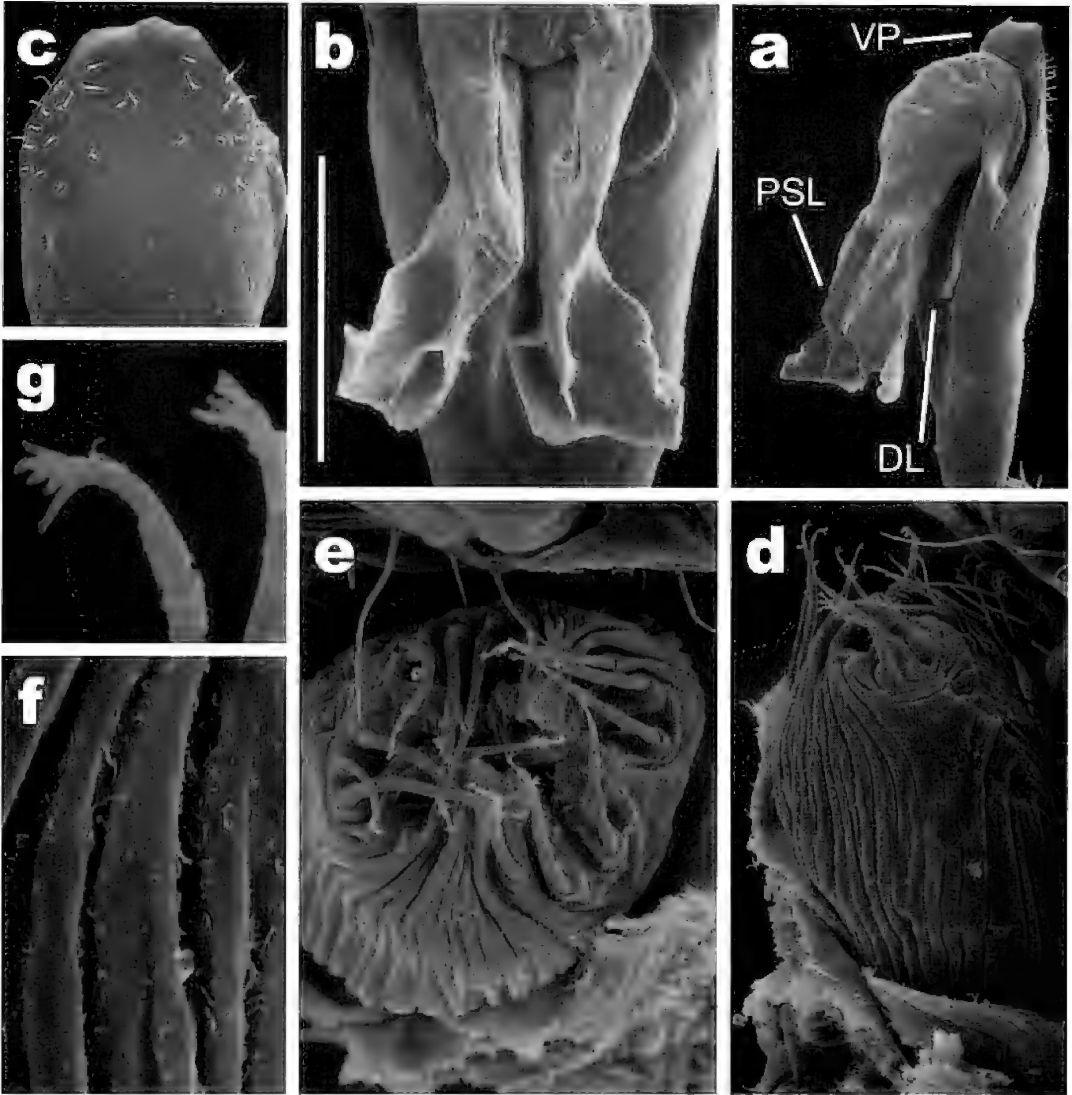


FIGURE 18. *Sitalcina sura* Briggs, genitalic morphology. a–c. Male, penis with unexpanded glans in (dextero)laterodorsal (a), dorsal (b), and ventral (c) views. d–g. Female, ovipositor, sinistrolateral (d) and apical (e) views, showing lateral surface lacking microspines (f) and setal tips (g). DL = dorsal lobe, PSL = parastylar lobe, VP = ventral plate. Scale bar = 460 μ m (a), 310 μ m (c), 230 μ m (d), 190 μ m (b), 98 μ m (e), 38 μ m (f), 21 μ m (g).

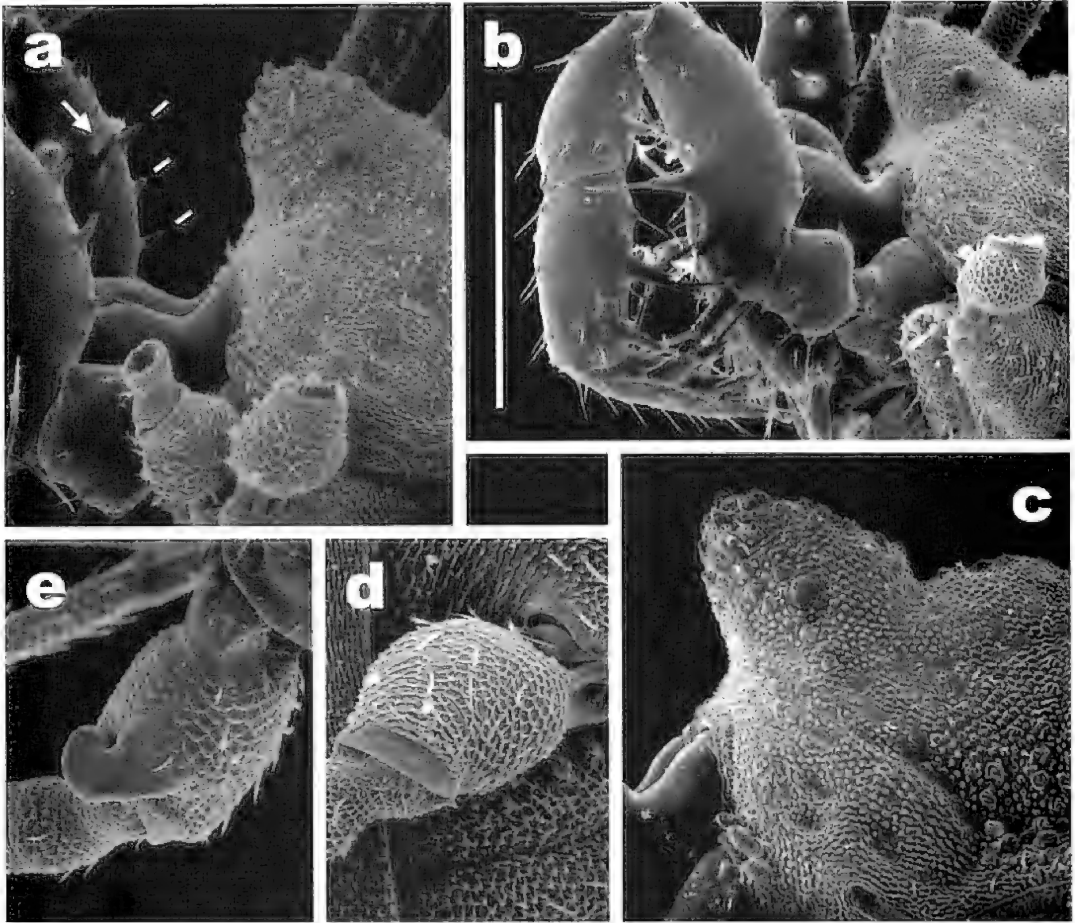


FIGURE 19. *Sitalcina seca* sp. nov., somatic morphology. a, c. Male. b–d. Female. a–c. Cephalon and palpi, lateral view, with palpal femur showing asetose dorsal tubercles (lines) and mesal tubercle (arrow). c. cephalon of female from Big Creek. d–e. Trochanter IV in lateral (d) and ventral (e) views. (All specimens from Arroyo Seco, except 'c' from Big Creek.) Scale bar = 550 μ m (b), 400 μ m (c), 380 μ m (a), 290 μ m (d–e).

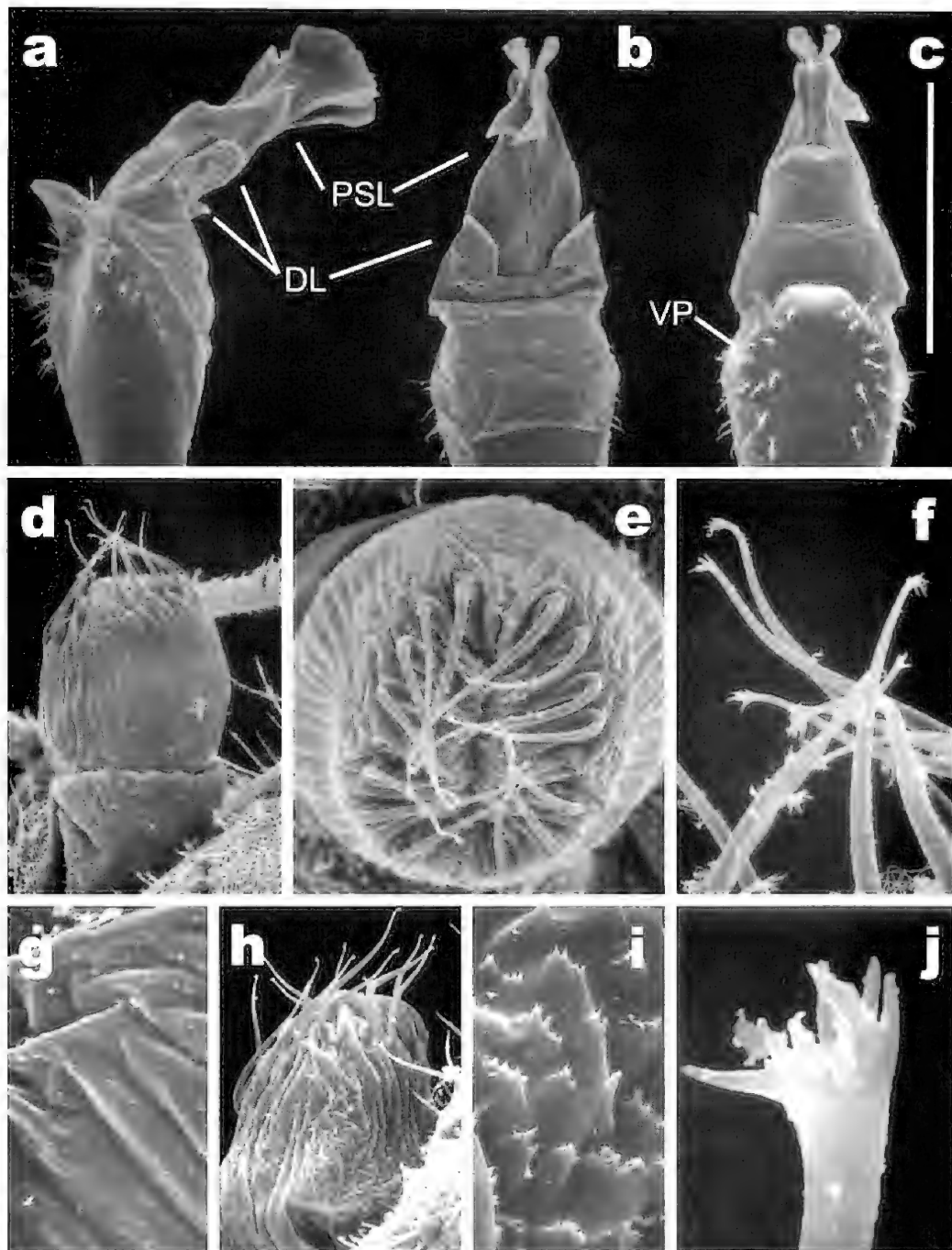


FIGURE 20. *Sitalcina seca* sp. nov., genitalia morphology. a–c. Male, penis with expanded glans in sinistrolateral (a), dorsal (b), and ventral (c) views. d–g. Female from Arroyo Seco, ovipositor in sinistrolateral (d) and apical (e) views, with close-up of apical setae (f) and lateral surface lacking microspines (g). h–j. Female from Big Creek, ovipositor in sinistrolateral view (h), with close-up of lateral surface showing microspines (i) and apical setae (j). DL = dorsal lobe, PSL = parastylar lobe, VP = ventral plate. Scale bar = 300µm (d), 190µm (a–c), 235µm (h), 143µm (e), 56µm (f), 38µm (g), 27µm (i), 5µm (j).

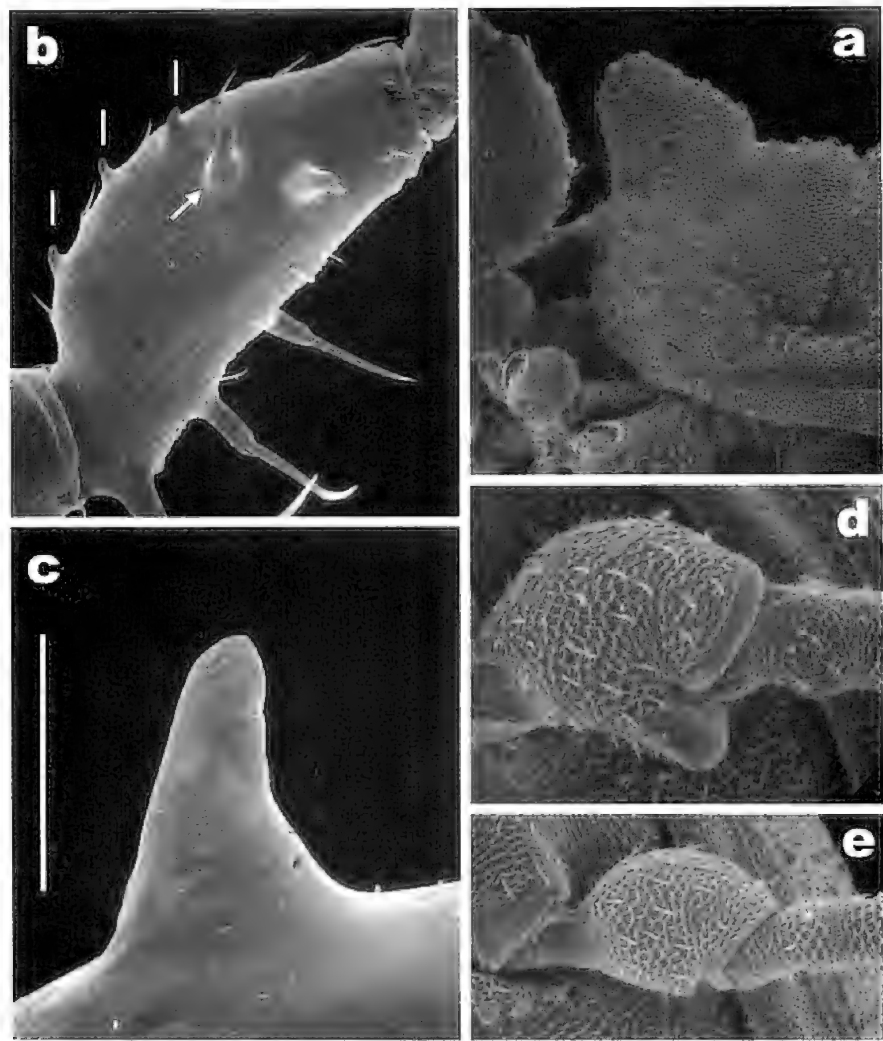


FIGURE 21. *Sitalcina chalone* Briggs, somatic morphology. a–d. Male. e. Female. a. Cephalon, lateral view. b. Palpal femur, mesal view showing dorsal (lines) and mesal (arrow) asetose tubercles. c. Dorsal asetose tubercle. d–e. Trochanter IV, ectal view. Scale bar = 480 μ m (a), 275 μ m (e), 230 μ m (b, d), 48 μ m (c).

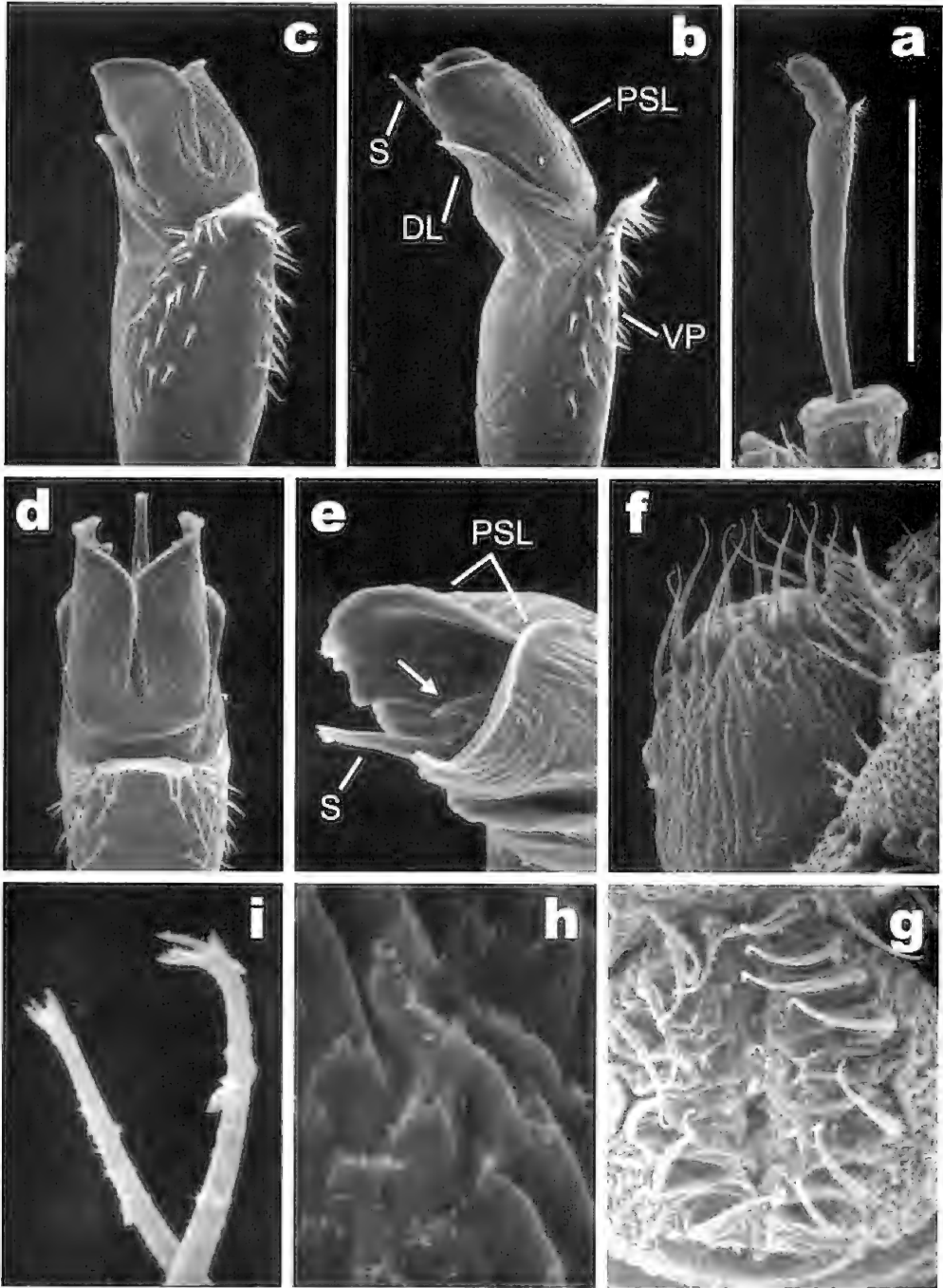


FIGURE 22. *Sitalcina chalonga* Briggs, genitalic morphology. a-e. Male, penis with expanded glans in sinistrolateral view (a) and glans in lateral (b), lateroventral (c), ventral (d), and lateroapical (e) views, with arrow showing ventral prong of stylus. f-i. Female, ovipositor, sinistrolateral (f) and apical (g) views, with lateral surface showing microspines (h), and apical setae (i). DL = dorsal lobe, PSL = parastylar lobe, S = stylus, VP = ventral plate. Scale bar = 570 μ m (a), 190 μ m (b-d, f), 145 μ m (g), 100 μ m (e), 19 μ m (h-i).

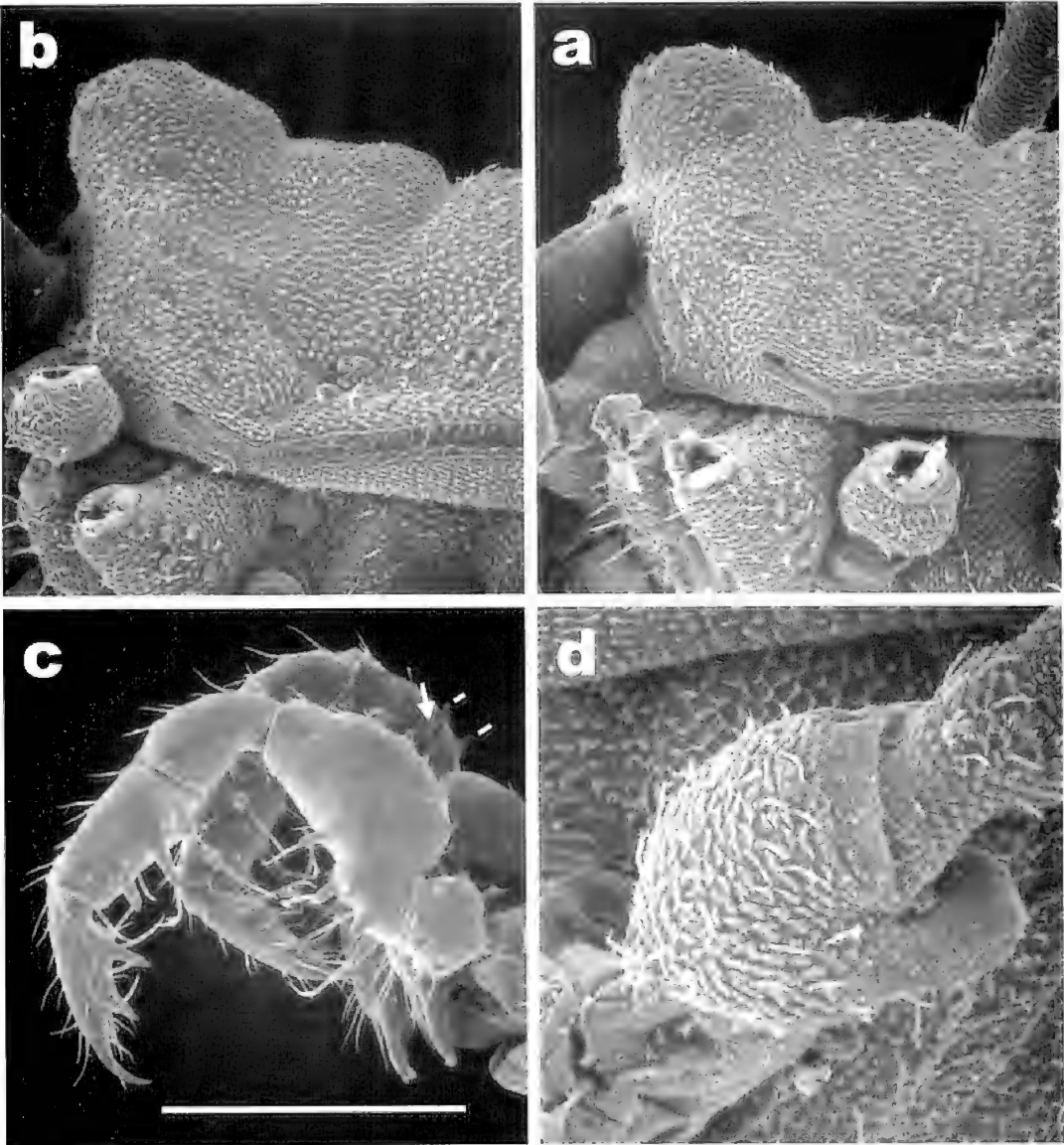


FIGURE 23. *Sitalcina flava* Briggs, somatic morphology. a. Female. b-d. Male. a-b. Cephalon, lateral view. c. Palpi, lateral view showing dorsal (lines) and mesal (arrow) asetose tubercles. c. Trochanter IV, ectal view. Scale bar = 490 μ m (c), 330 μ m (a-b), 165 μ m (d).

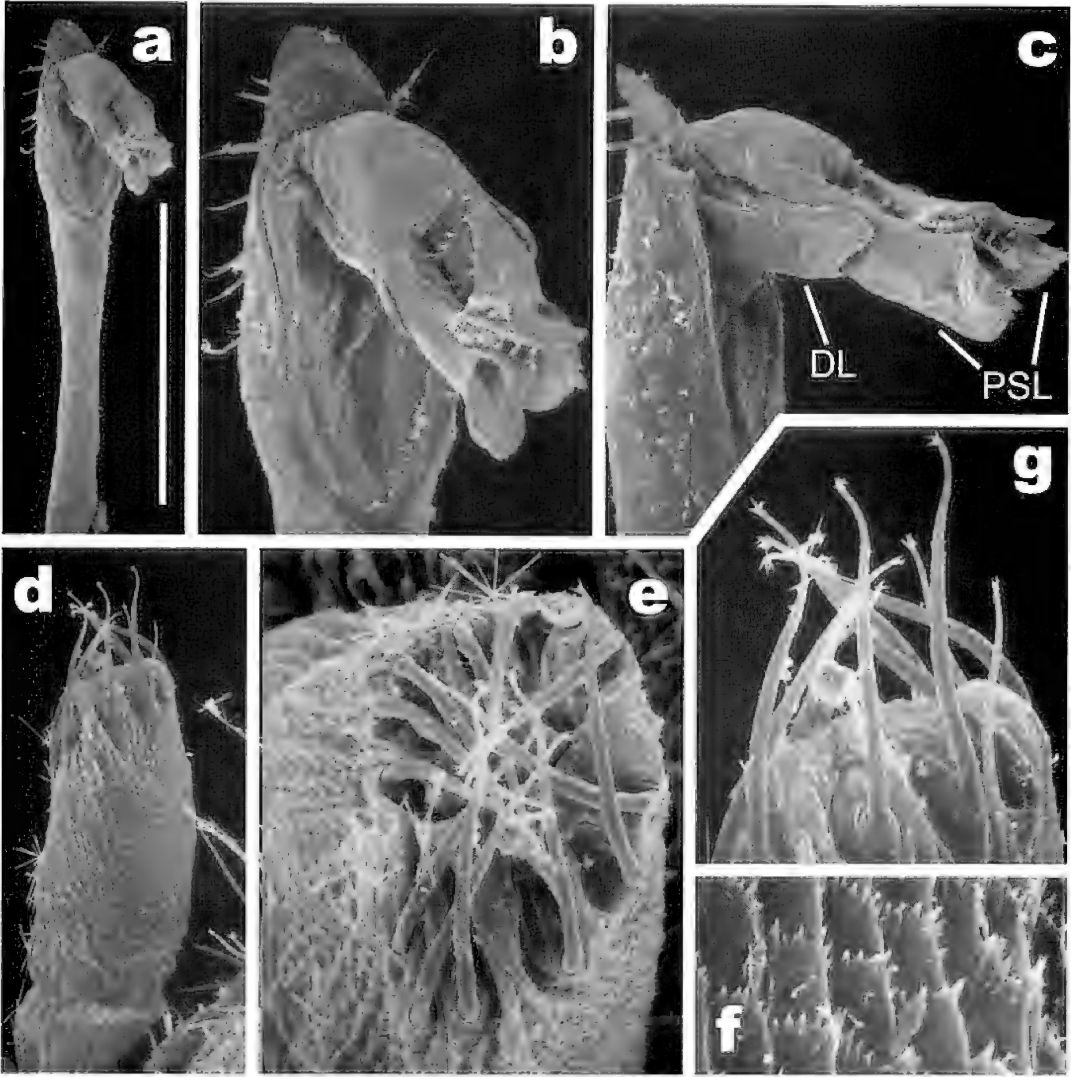


FIGURE 24. *Sitalcina flava* Briggs, genitalic morphology. a-c. Male, penis with partially expanded glans in (sinistro)dorsolateral view (a) and glans in dorsolateral (b) and sinistrolateral (c) views. d-g. Female, ovipositor, sinistrolateral (d) and apical (e) views, with lateral surface showing microspines (f), and apex showing setae (g). DL = dorsal lobe, PSL = parastylar lobe. Scale bar = 285 μ m (a), 190 μ m (d), 115 μ m (b-c), 82 μ m (c), 70 μ m (g), 19 μ m (f).

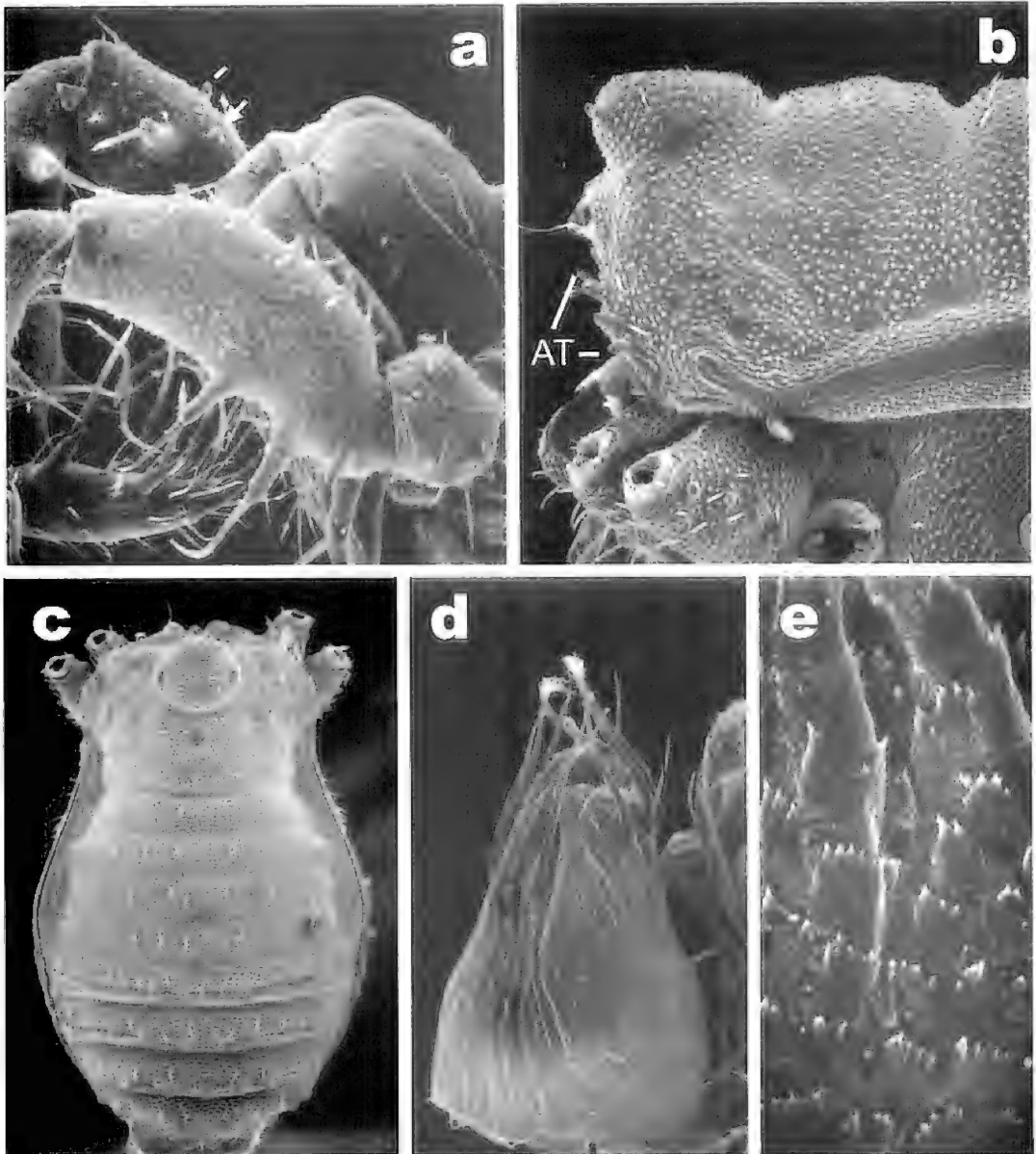


FIGURE 25. *Sitalcina borregoensis* Briggs, female, morphology. a. Palpi and chelicerae, lateral view showing dorsal (lines) and mesal (arrow) asetose tubercles. b. Cephalon, lateral view. c. Body, dorsal view. d. Ovipositor, lateral view. e. Ovipositor surface showing microspines. AT = anterior tubercles. Scale bar = 610 μ m (c), 260 μ m (b), 250 μ m (a), 130 μ m (d), 13 μ m (e).

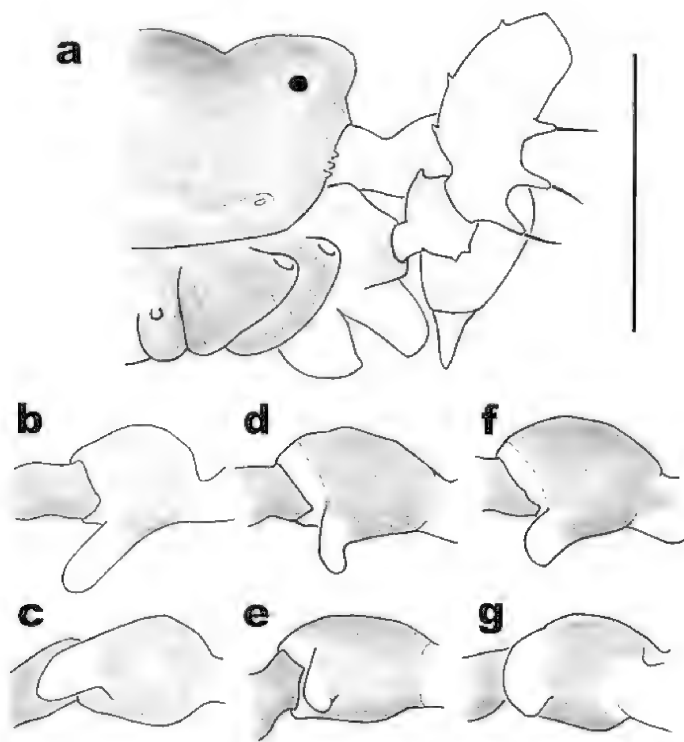


FIGURE 26. *Sitalcina* spp., Arizona clade, somatic morphology. a–c. *S. rothi* sp. nov. d–e. *S. catalina* sp. nov. f–g. *S. peacheyi* sp. nov. a. Cephalic region, lateral view of female. b–g. Male TrIV in ectal (b, d, f) and ventral (c, e, g) views; shading indicates regions of rugosity. Scale bar = 500µm (a), 350µm (b–g).

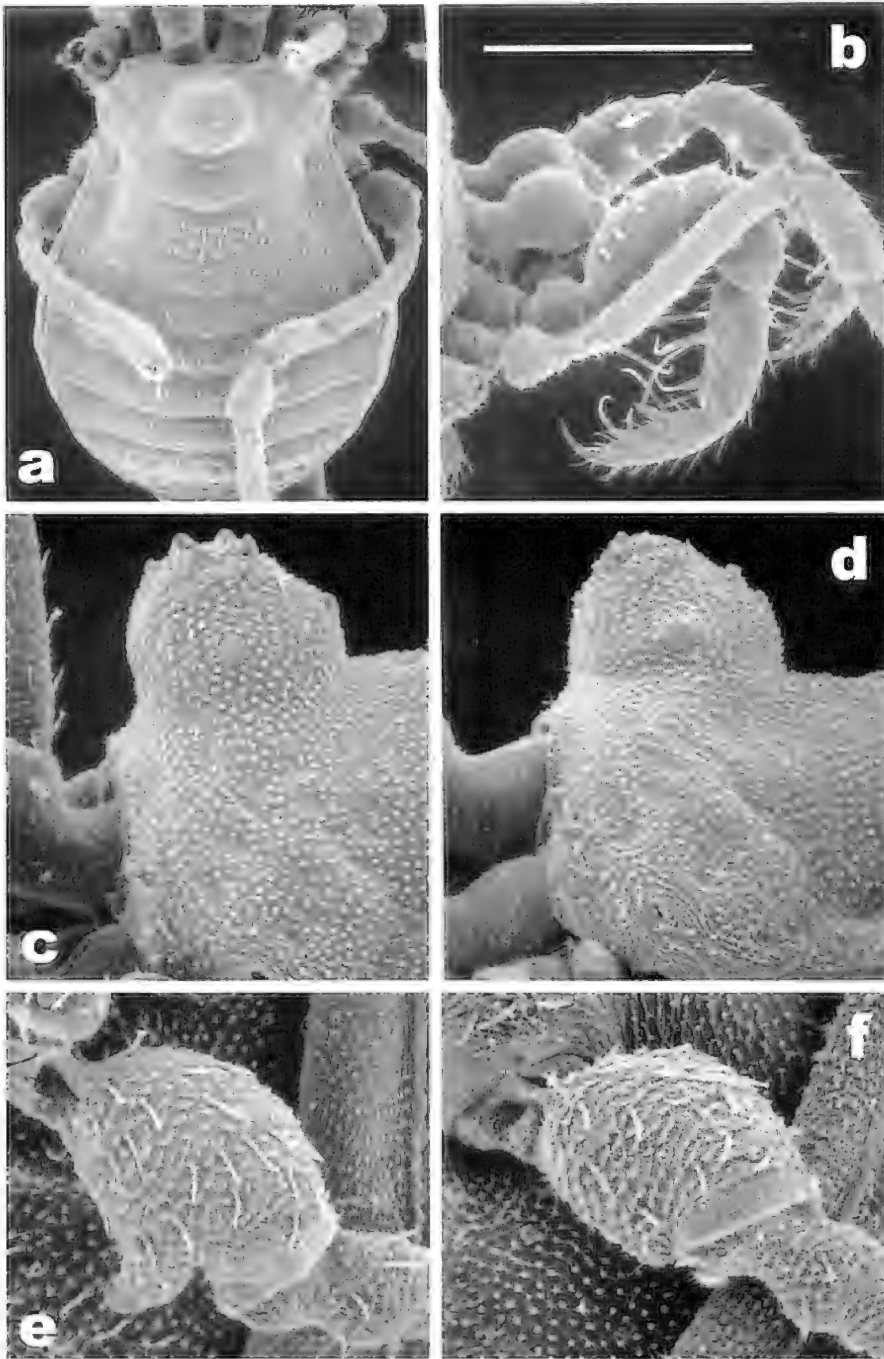


FIGURE 27. *Sitalcina catalina* sp. nov., somatic morphology. a, c, e. Male. b, d, f. Female. a. Body, dorsal view. b. Palpi and chelicerae, lateral view showing dorsal (lines) and mesal (arrow) asetose tubercles. c-d. Cephalon, lateral view. e-f. Trochanter IV, ectal view. Scale bar = 750 μ m (a), 530 μ m (b), 180 μ m (c-f), 175 μ m (c-d).

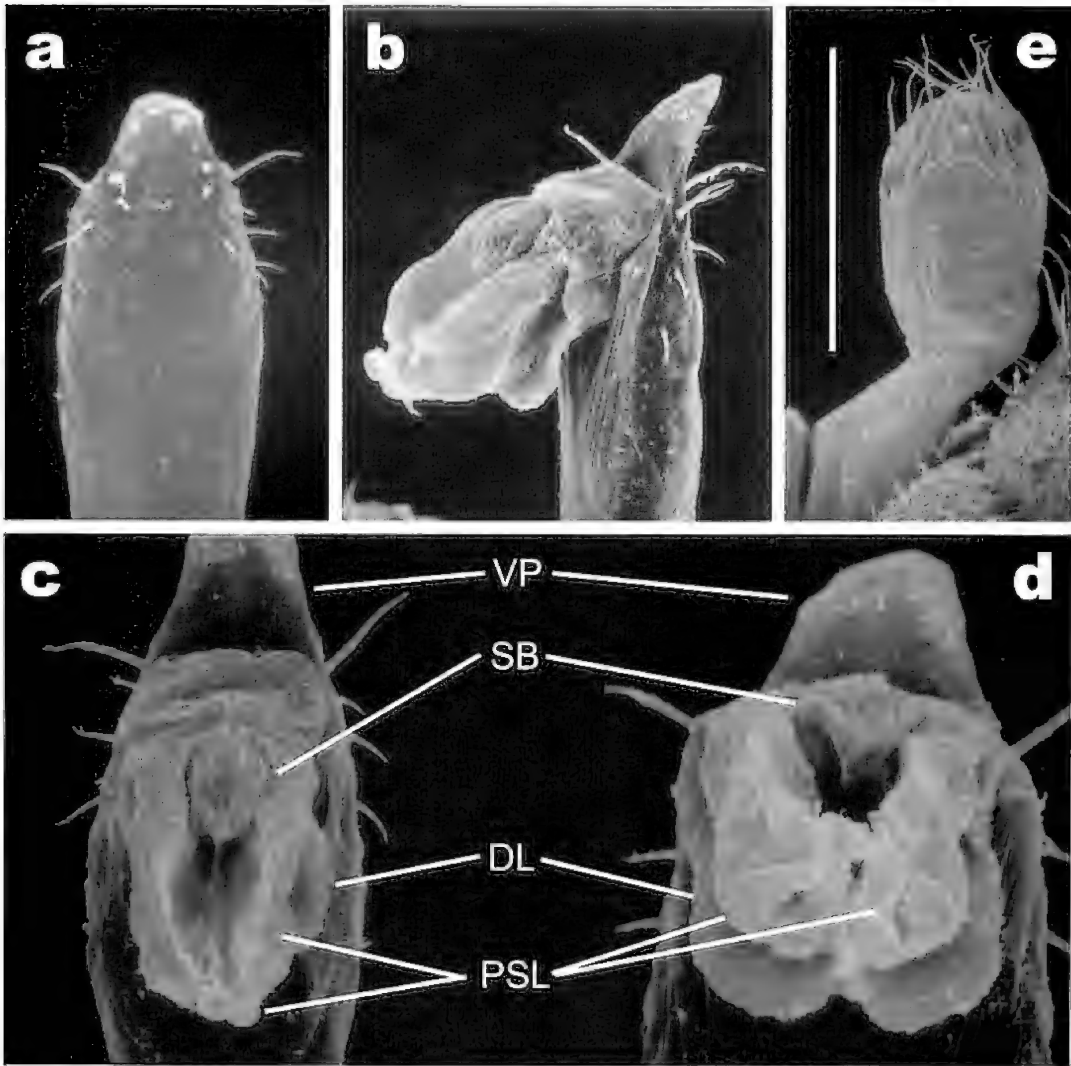


FIGURE 28. *Sitalcina catalina* sp. nov., genitalic morphology. a-d. Male, penis with partially expanded glans in ventral (a), dexterolateral (b), and dorsal (c) views, and tilted dorsal showing apical view of glans (d). e. Female, ovipositor, lateral view. DL = dorsal lobe, PSL = parastylar lobe, SB = stylar base, VP = ventral plate. Scale bar = 230 μ m (c), 115 μ m (a-b), 82 μ m (e), 57 μ m (d).

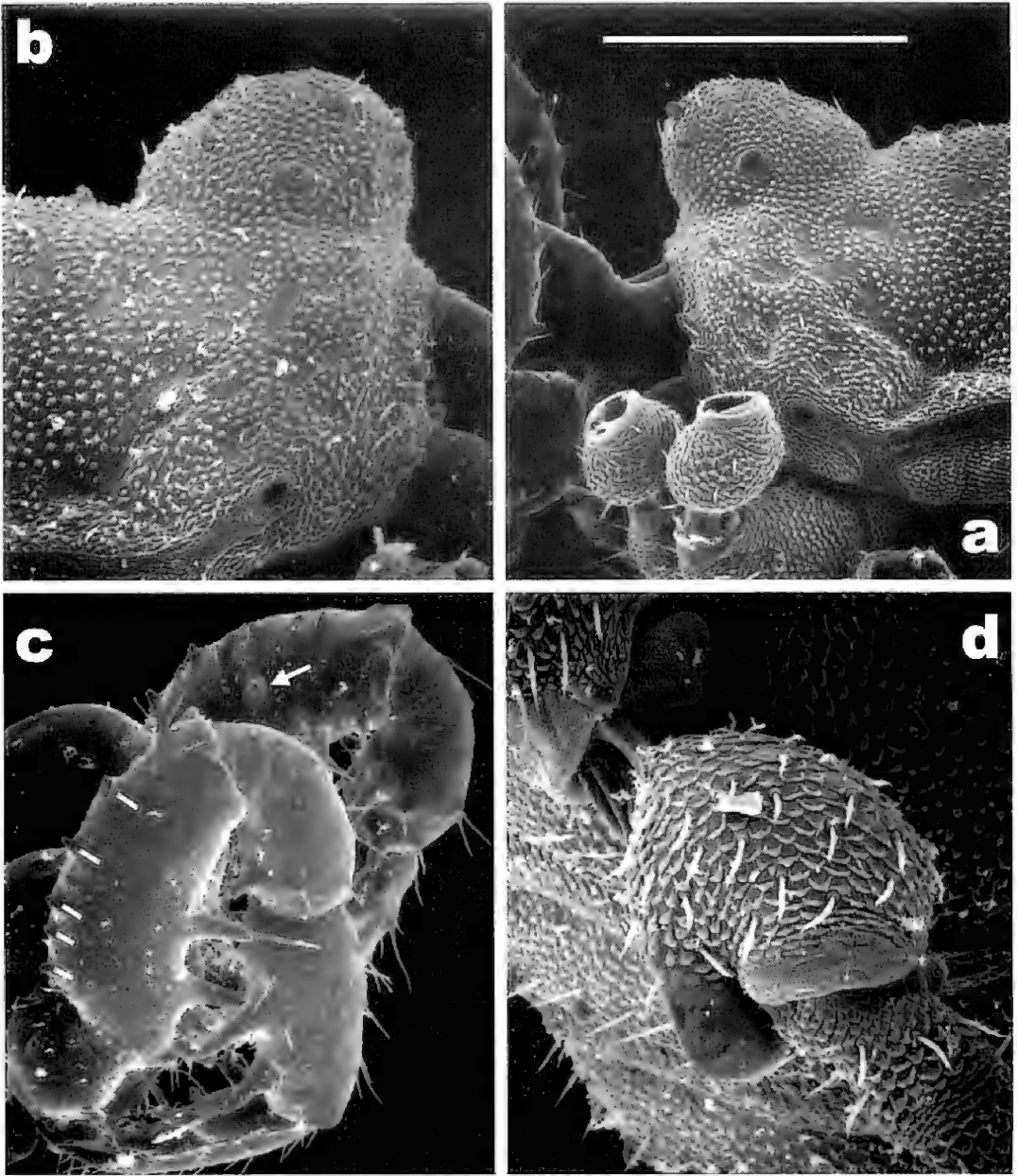


FIGURE 29. *Sitalcina peacheyi* sp. nov., somatic morphology. a. Female. b–d. Male. a–b. Cephalon, lateral view. c. Palpi, lateral view showing dorsal (lines) and mesal (arrow) asetose tubercles. d. Trochanter, ectal view. Scale bar = 330 μ m (a, c), 250 μ m (b), 165 μ m (d).

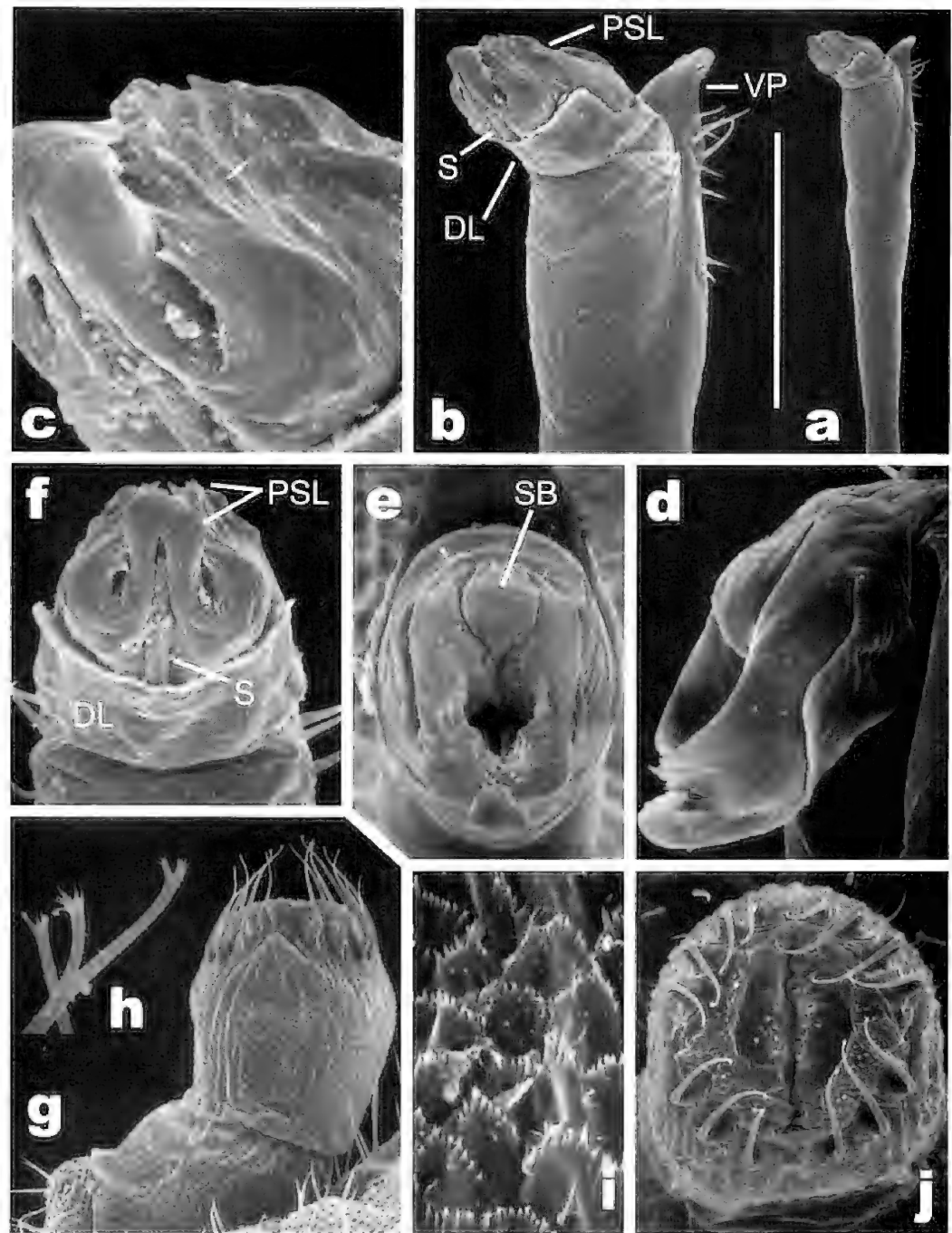


FIGURE 30. *Sitalcina peacheyi* sp. nov., genitalic morphology. a–f. Male, penis. a–c. f. Partially expanded glans, in dexterolateral views (a–c) and in dorsal view showing ventroapical aspect of glans (f). d–e. Folded glans in dorsolateral (d) and ventroapical (e) views. g–j. Female, ovipositor, lateral (g) and apical (j) views with apical setae (h) and lateral surface showing microspines (i). DL = dorsal lobe, PSL = parastylar lobe, S = stylus, SB = stylus base, VP = ventral plate. Scale bar = 270µm (a), 230µm (g), 150µm (j), 115µm (b), 90µm (e), 67µm (d), 63µm (i), 30µm (c), 20µm (i).

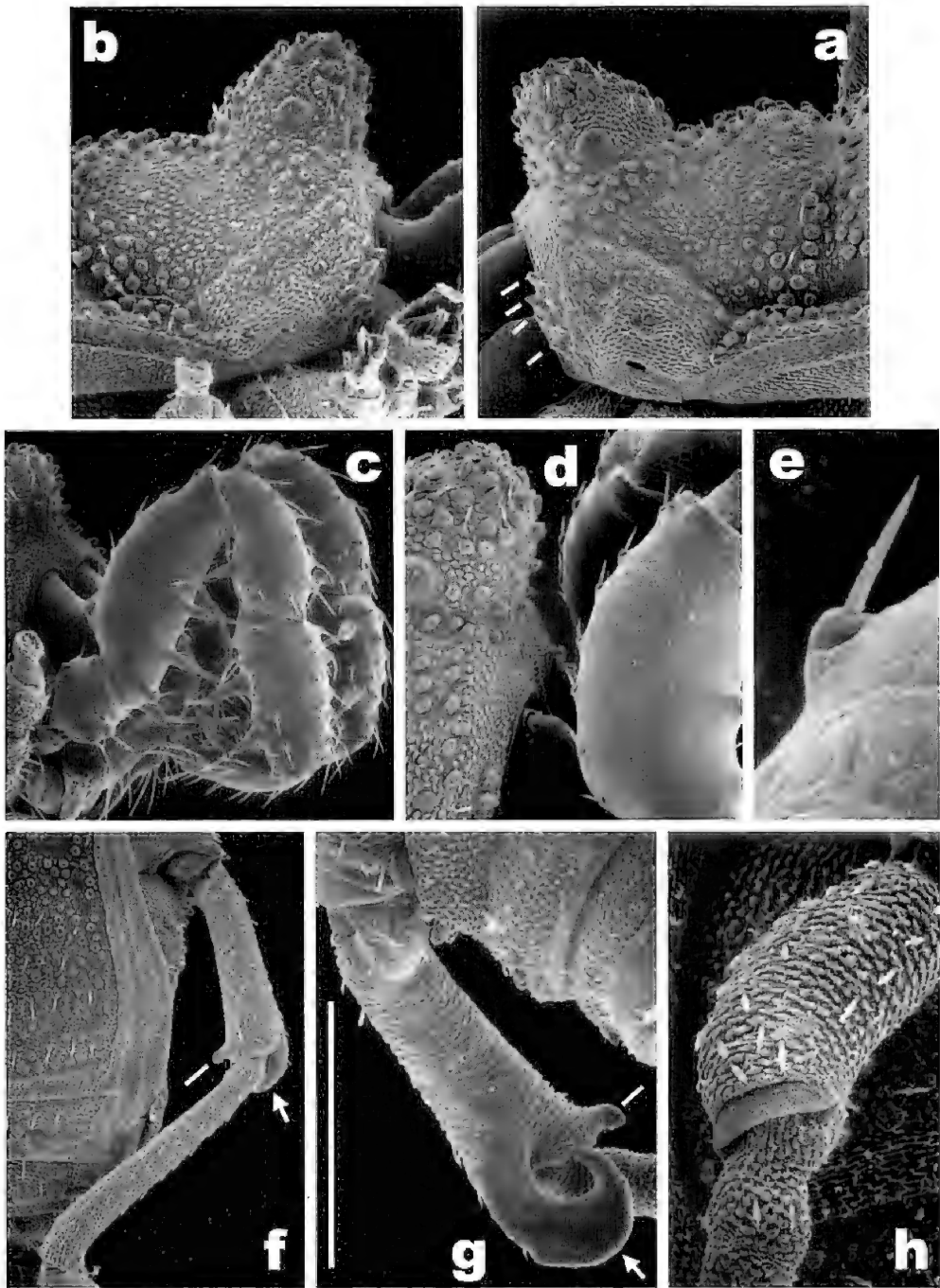


FIGURE 31. *Sitalcina lobata* Goodnight and Goodnight, somatic morphology. a, h. Female. b–g. Male. a–b. Cephalon, lateral view, showing prominent AT (lines). c–e. Palpi, lateral view, with detail of femur (d) and setose tubercle (e). f–h. Trochanter IV, of male in dorsal (f) and ventral (g) views, showing mesal (line) and ectal (arrow) distal processes (spurs), and female in ectal view (h). Scale bar = 570 μ m (f), 475 μ m (c), 380 μ m (a–b), 330 μ m (d), 285 μ m (g), 210 μ m (h), 55 μ m (e).

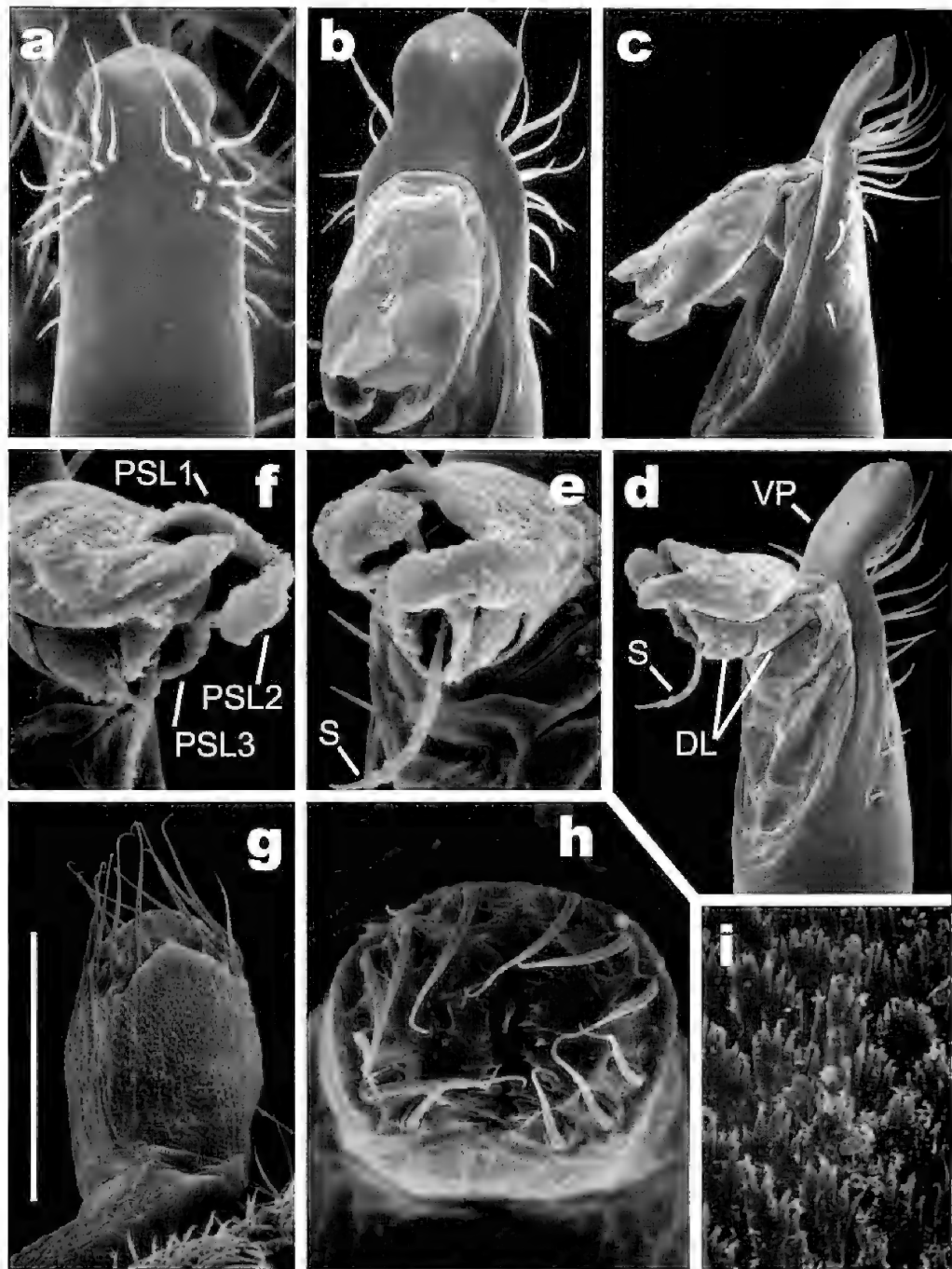


FIGURE 32. *Sitalcina lobata* Goodnight and Goodnight, genitalic morphology. a–f. Male. a–c. Penis with partially expanded glans in ventral (a), dorsal (b), and dexterolateral (c) views. d–f. Penis more fully expanded, dorsolateral view (d), with glans in apical (e) and sinistrolateral (f) views. g–i. Female, ovipositor in sinistrolateral (g) and apical (h) views, with lateral surface showing microspine arrangement (i). DL = dorsal lobe, PSL1 = ventral branch of parastylar lobe, PSL2 = lateral branch, PSL3 = dorsal branch, S = stylus, VP = ventral plate. Scale bar = 190 μ m (g), 120 μ m (a–d), 115 μ m (h), 75 μ m (e–f), 19 μ m (i).

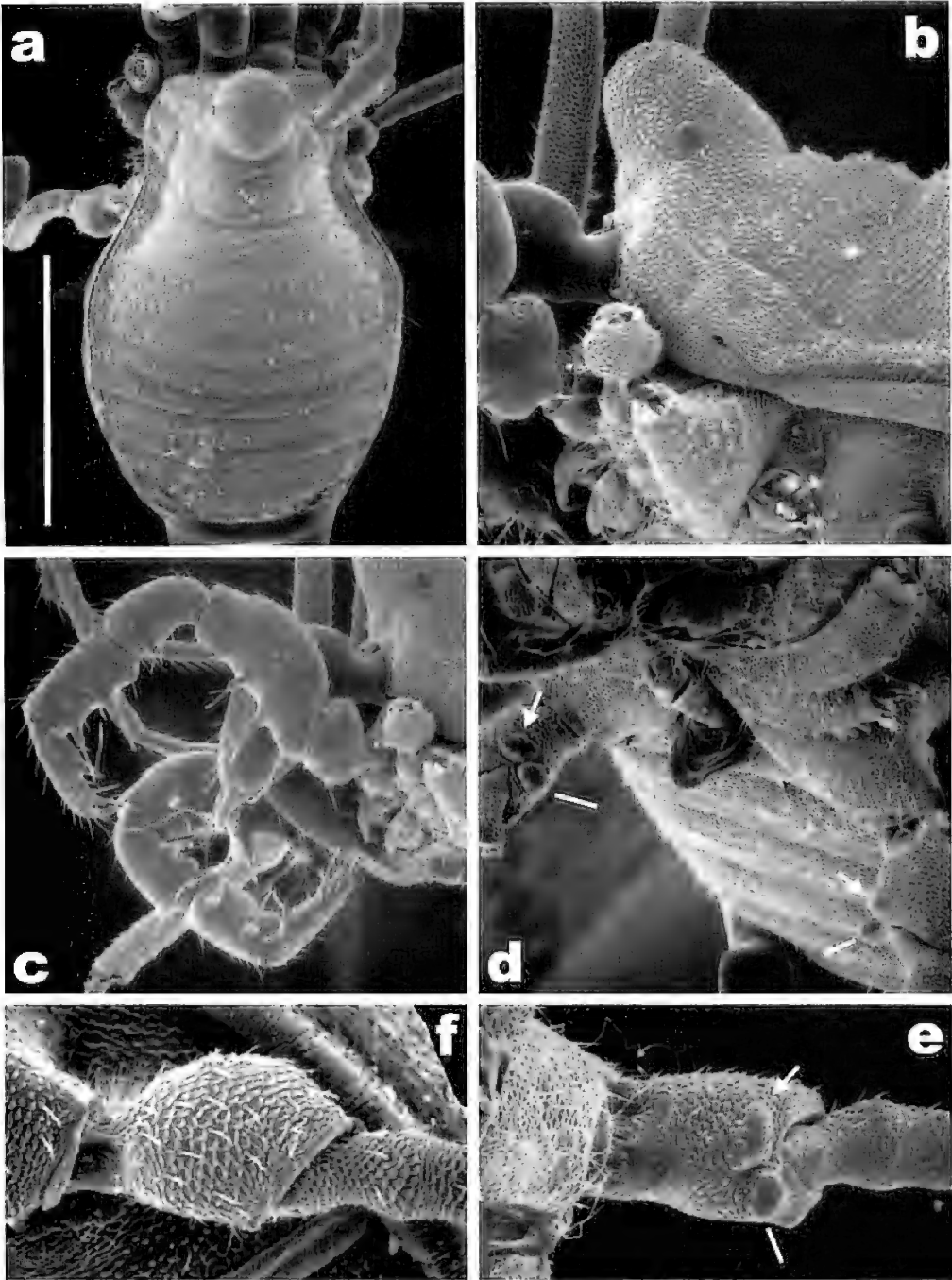


FIGURE 33. *Enigmima granita* (Briggs), somatic morphology. a–e. Male. f. Female. a. Body, dorsal view. b. Cephalon, lateral view. c. Palpi, lateral view. d. Venter showing trochanters with ectal (arrow) and mesal (line) processes. e. Male trochanter IV, ventral view. f. Female trochanter IV ectal view. Scale bar = 1mm (a), 720 μ m (c–d), 500 μ m (b), 330 μ m (e), 260 μ m (f).

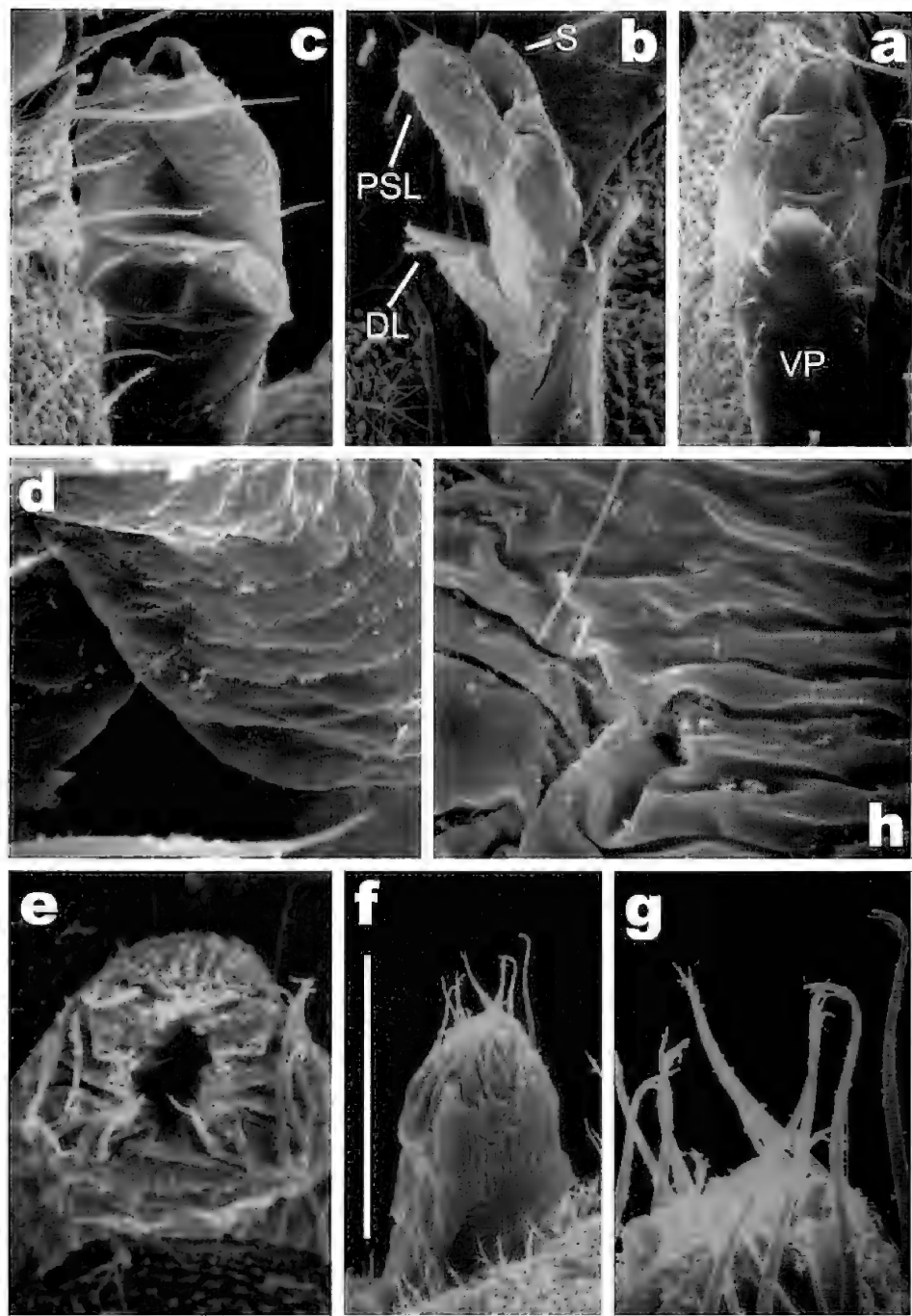


FIGURE 34. *Enigmima granita* (Briggs), genitalic morphology. a–d. Male, penis fully expanded in ventral (a), dextro-lateral (b), and dorsal (c) views, with dorsal aspect of PSL (d). e–h. Female, ovipositor in apical (e) and sinistrolateral (f) views showing polyfurcate apical setae (g) and lateral surface of ovipositor (distal end to left) lacking microspines (h). DL = dorsal lobe, PSL = parastylar lobe, S = stylus, VP = ventral plate. Scale bar = 180 μ m (f), 135 μ m (a), 115 μ m (b), 110 μ m (c, e), 55 μ m (g), 27 μ m (d, h).

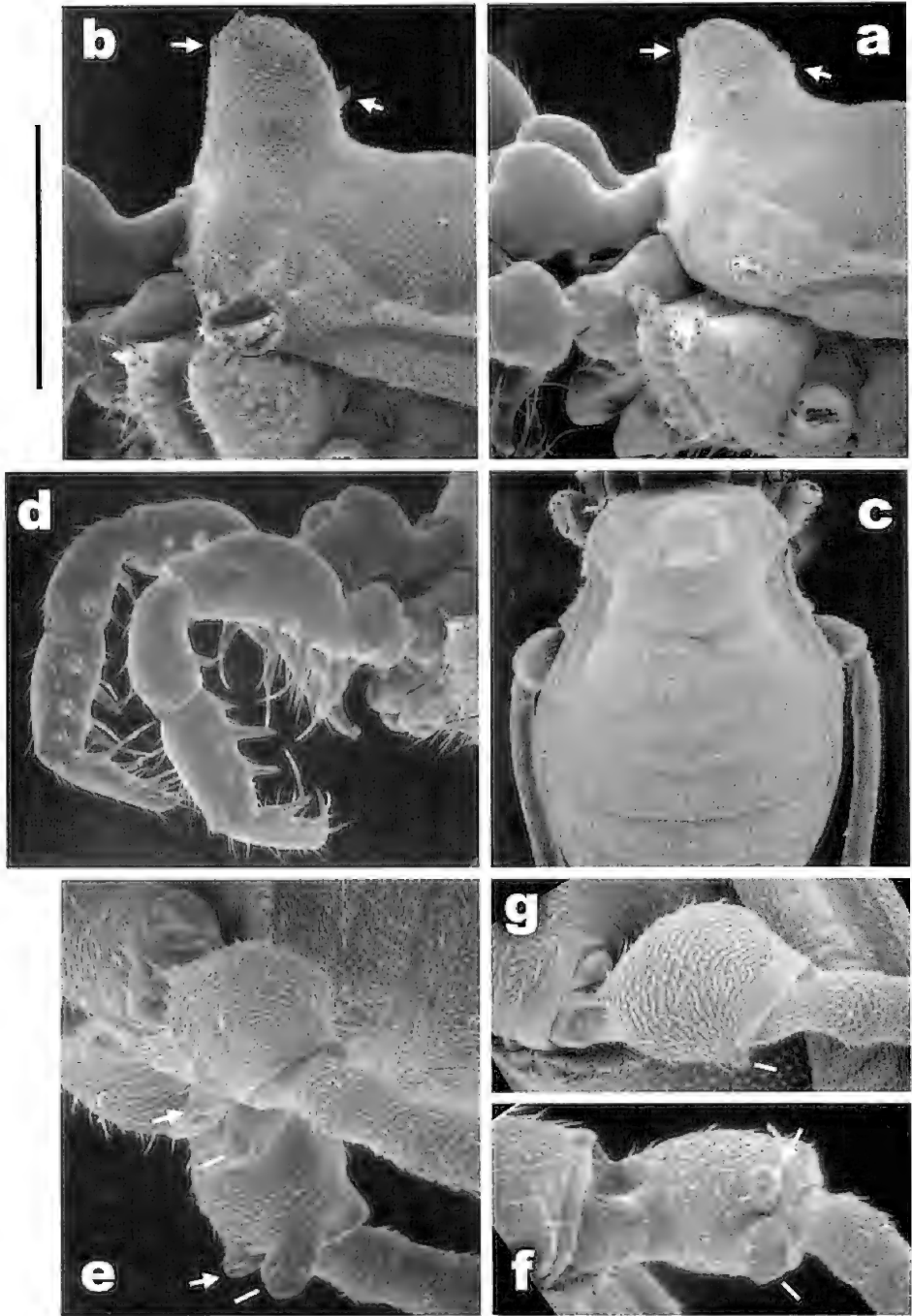


FIGURE 35. *Enigmima warrenorum* sp. nov., somatic morphology. a, g. Female. b–f. Male. a–b. Cephalon, lateral view showing crown of pointed tubercles (arrows). c. Body, dorsal view. d. Palpi, lateral view. e–f. Male trochanter IV in lateral (e) and ventral (f) views, showing ectal (arrow) and mesal (line) processes. g. Female trochanter IV, ectal view, showing small tubercle (line). Scale bar = 1.1mm (c), 820 μ m (d), 560 μ m (a), 520 μ m (b), 360 μ m (e–f), 300 μ m (g).

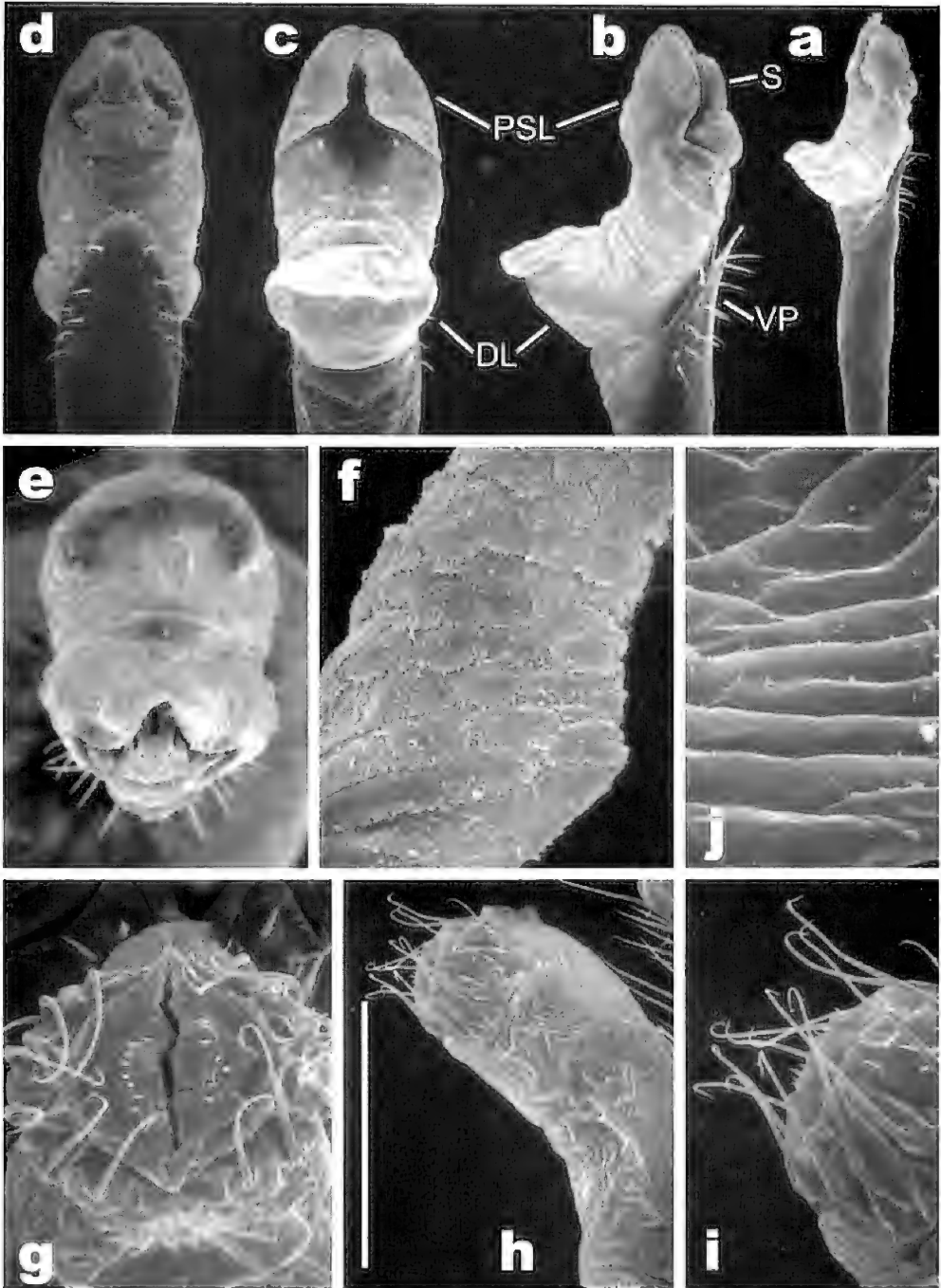


FIGURE 36. *Enigmima warrenorum* sp. nov., genitalie morphology. a–f. Male, penis fully expanded in dexterolateral (a–b), dorsal (c), ventral (d), and apical (e) views, with dorsal aspect of PSL (f). g–j. Female, ovipositor, in apical (g) and sinistrolateral (h) views, showing pointed apical setae (i) and lateral surface lacking microspines (j). DL = dorsal lobe, PSL = parastylar lobe, S = stylus, VP = ventral plate. Scale bar = 300 μ m (a), 285 μ m (h), 170 μ m (b–d), 145 μ m (g, i), 110 μ m (e), 28 μ m (f, j).

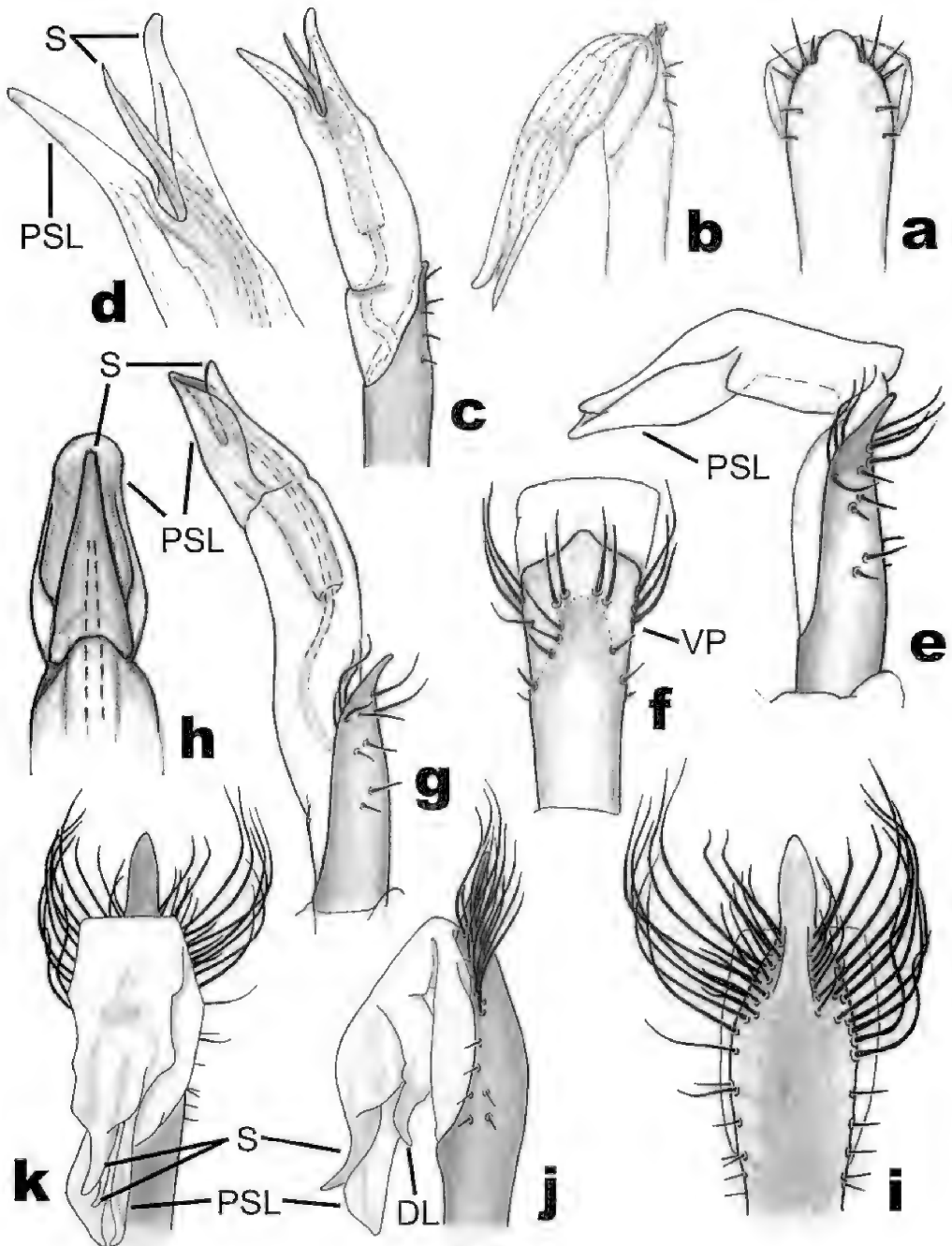


FIGURE 37. *Tularina* gen. nov., male genitalia. a-d. *T. tularensis* sp. nov., penis, unexpanded in ventral (a) and dexterolateral (b) views, and expanded in dexterolateral view (c-d). e-h. *T. plumosa* sp. nov., penis, partially expanded in dexterolateral (e) and ventral (f) views, and fully expanded in dexterolateral (g) and ventral views (h). i-k. *T. scopula* (Briggs), penis unexpanded in ventral (i), dexterolateral (j), and dorsal (k) views. DL = dorsal lobe, PSL = parastylar lobe, S = stylus, VP = ventral plate.

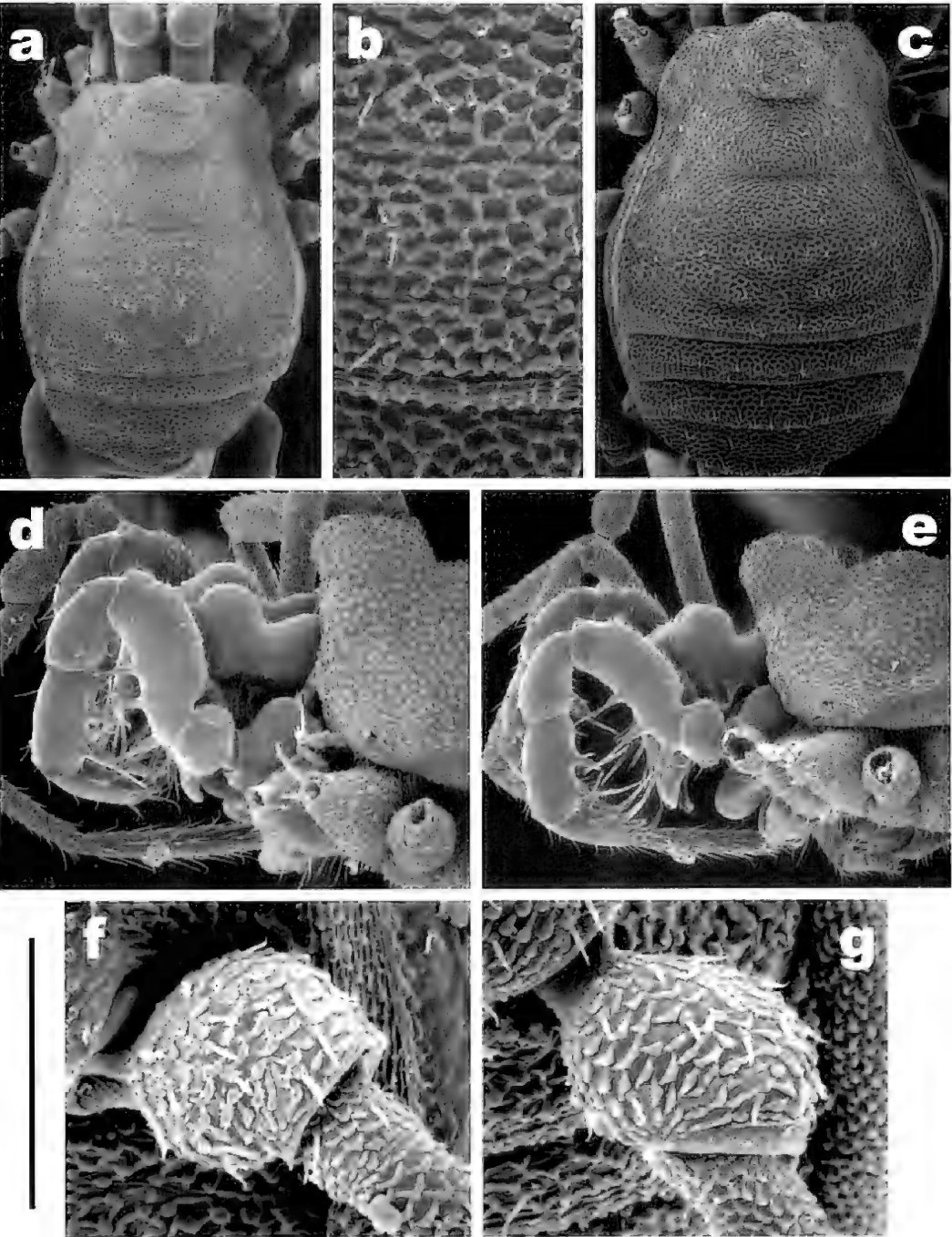


FIGURE 38. *Tularina tularensis* sp. nov., somatic morphology. a-b, d, f. Male. c, e, g. Female. a-c. Body, dorsal view, with central region showing areolate cuticle (b). d-e. Cephalon and palpi, lateral view. f-g. Trochanter IV, ectal view. Scale bar = 600 μ m (a, c), 475 μ m (e), 380 μ m (d), 135 μ m (b), 115 μ m (f-g).

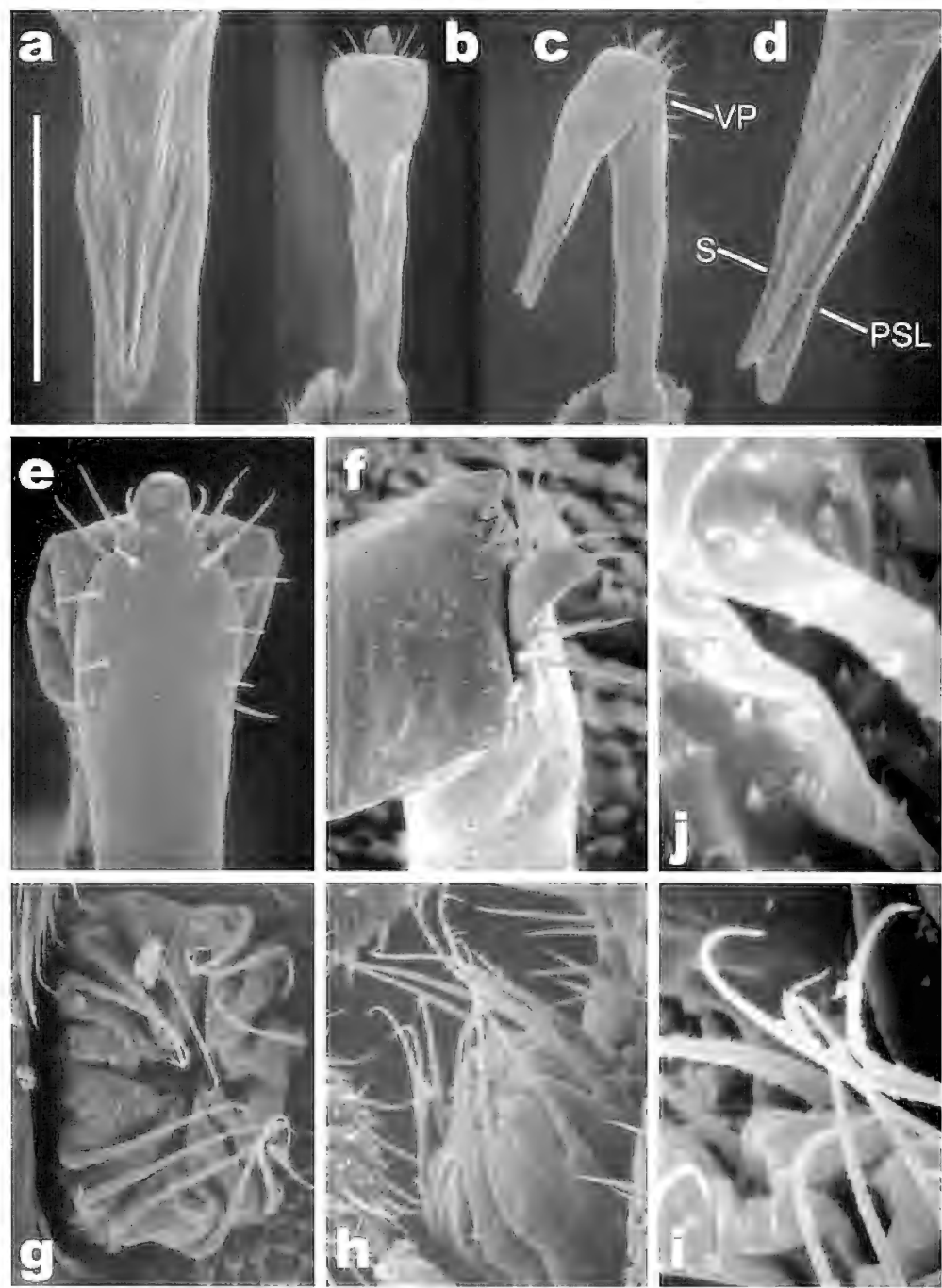


FIGURE 39. *Tularina tularensis* sp. nov., genitalic morphology. a–f. Male, penis partially expanded, in dorsal (a–b), dorsolateral (c–d), ventral (e), and apical (f) views. g–j. Female, ovipositor in apical (g) and sinistrolateral (h) views, showing hooked pointed apical setae (i) and lateral surface of ovipositor with microspines (j). PSL = parastylar lobe, S = stylus, VP = ventral plate. Scale bar = 190µm (b–c), 86µm (h), 78µm (a, d–e, g), 55µm (f), 28µm (i), 11µm (j).

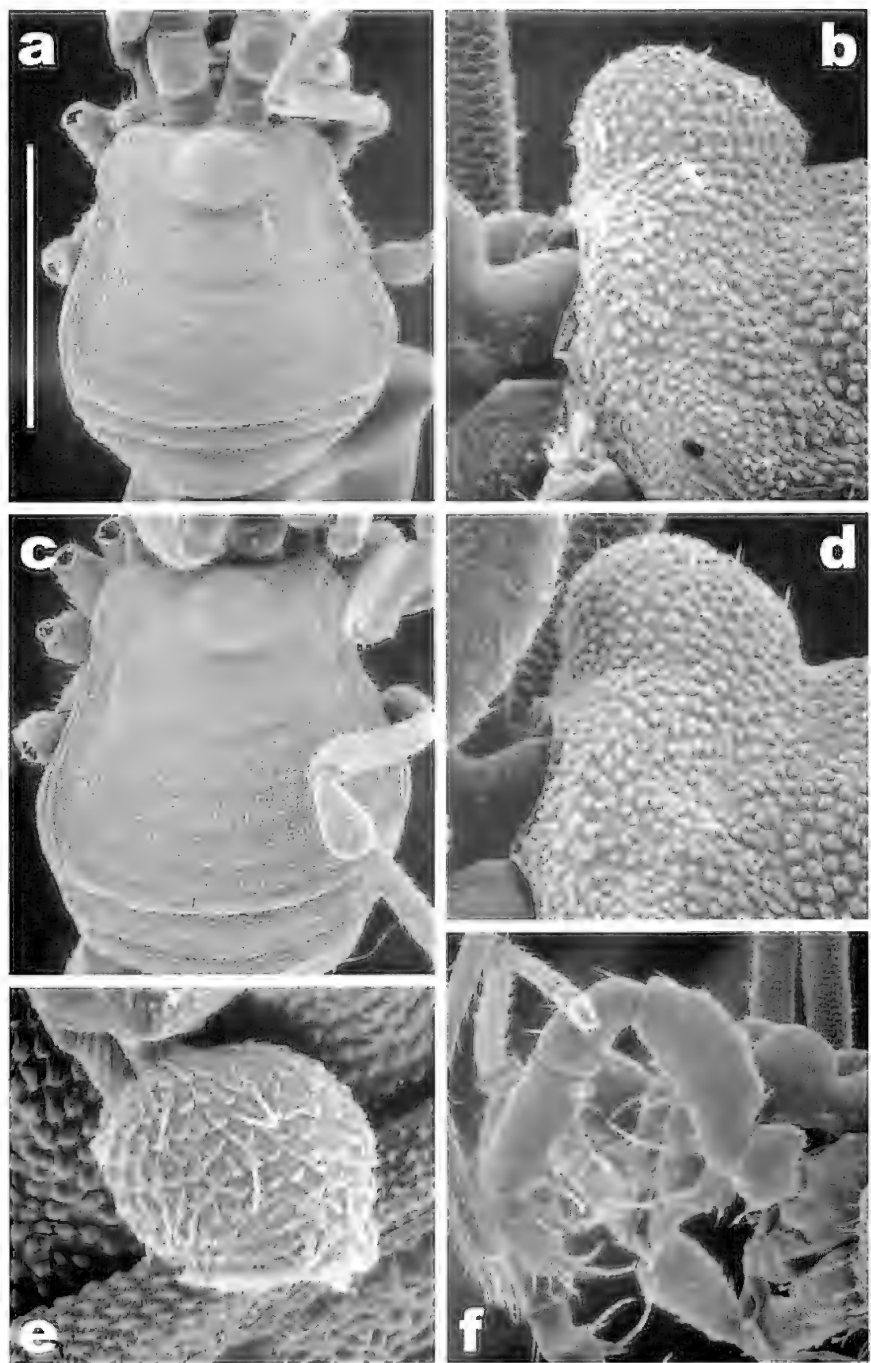


FIGURE 40. *Tularina plumosa* sp. nov., somatic morphology. a–b, c–f. Male. c–d. Female. a, c. Body, dorsal view. b–d. Cephalon, lateral view, showing degenerate eye (arrow). e. Male trochanter IV, ectal view. f. Chelicerae and palpi, lateral view. Scale bar = 570µm (a), 550µm (c), 360µm (f), 180µm (b, d), 110µm (e).

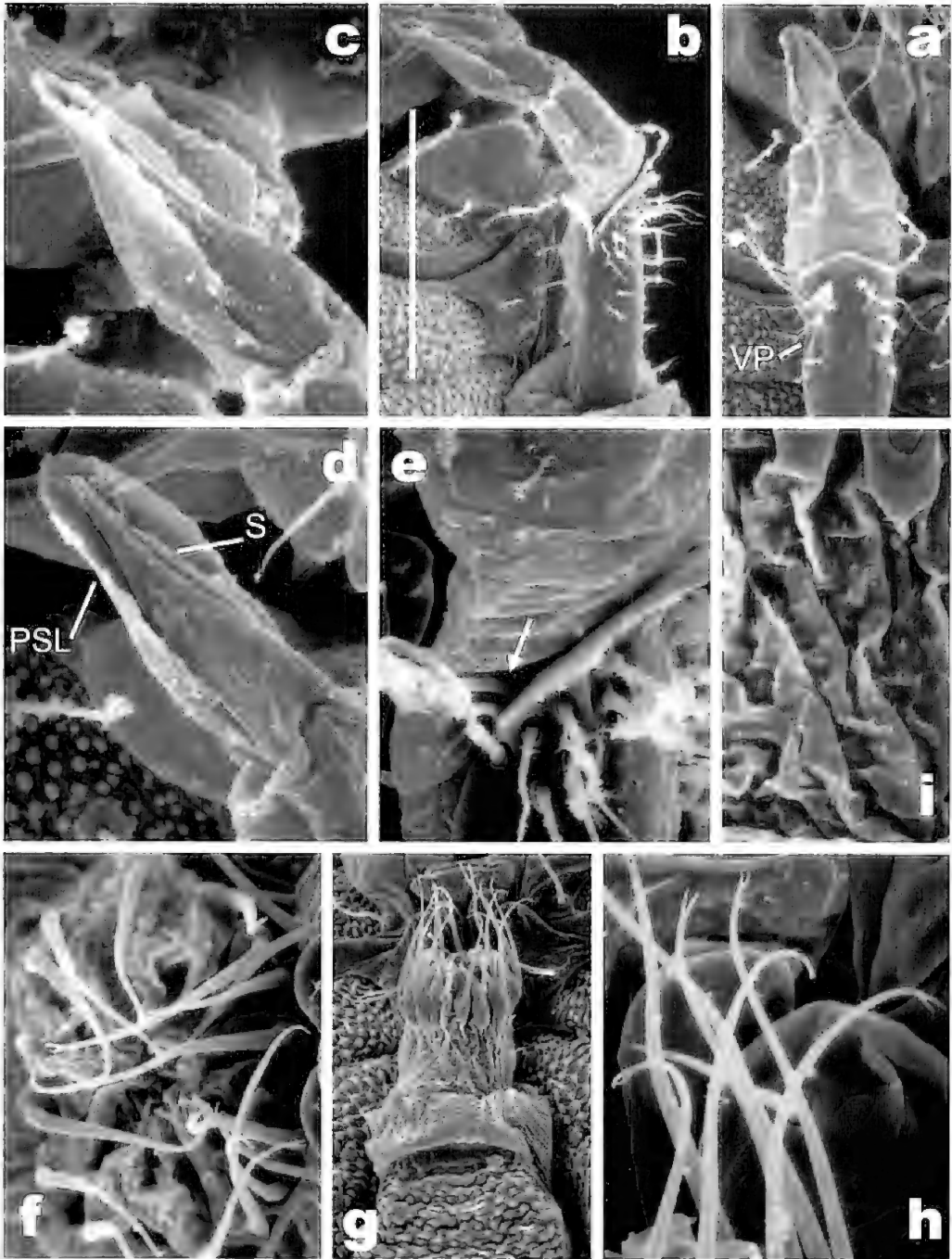


FIGURE 41. *Tularina plumosa* sp. nov., genitalic morphology. a-e. Male, penis, fully expanded, in ventral (a) and dexterolateral (b, e) views, with glans in lateral (c) and ventrolateral (d) views, and VP (e) showing dorsal setae (arrow). f-i. Female, ovipositor, in apical (f) and ventral (g) views, showing bifid apical setae (h) and lateral surface of ovipositor with microspines (i). PSL = parastylar lobe, S = stylus, VP = ventral plate. Scale bar = 190 μ m (a-b, g), 82 μ m (e-d), 60 μ m (c-f), 40 μ m (h-i).

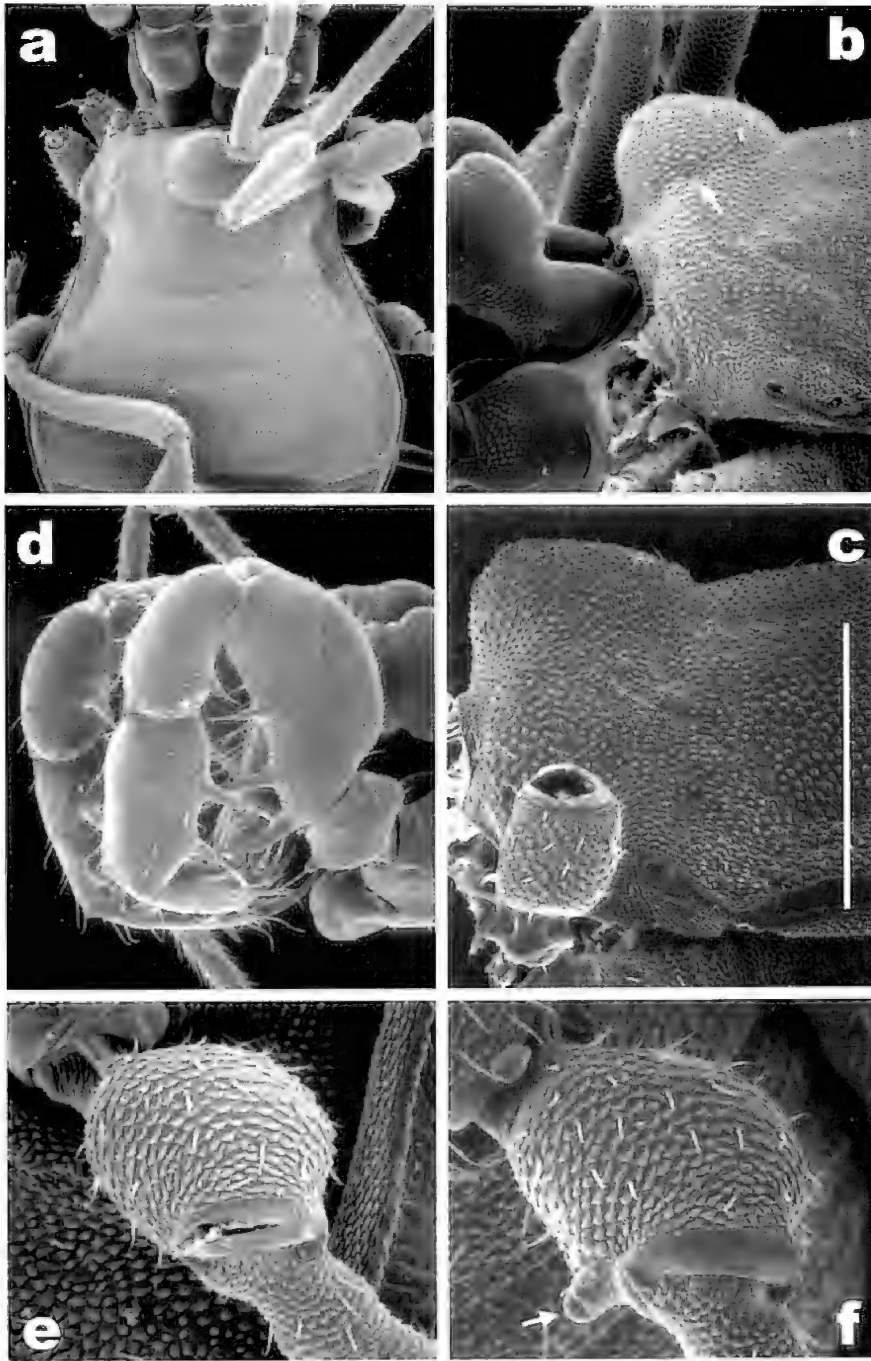


FIGURE 42. *Tularina scopula* (Briggs), somatic morphology. a–b, d–e. Female. c, f. Male. a. Body, dorsal view, b–c. Cephalon, lateral view, with arrow showing degenerate eye. d. Palpi, lateral view. e–f. Trochanter IV, ectal view, with arrow indicating tubercle in male. Scale bar = 780 μ m (a), 475 μ m (d), 380 μ m (b), 285 μ m (c), 190 μ m (e–f).

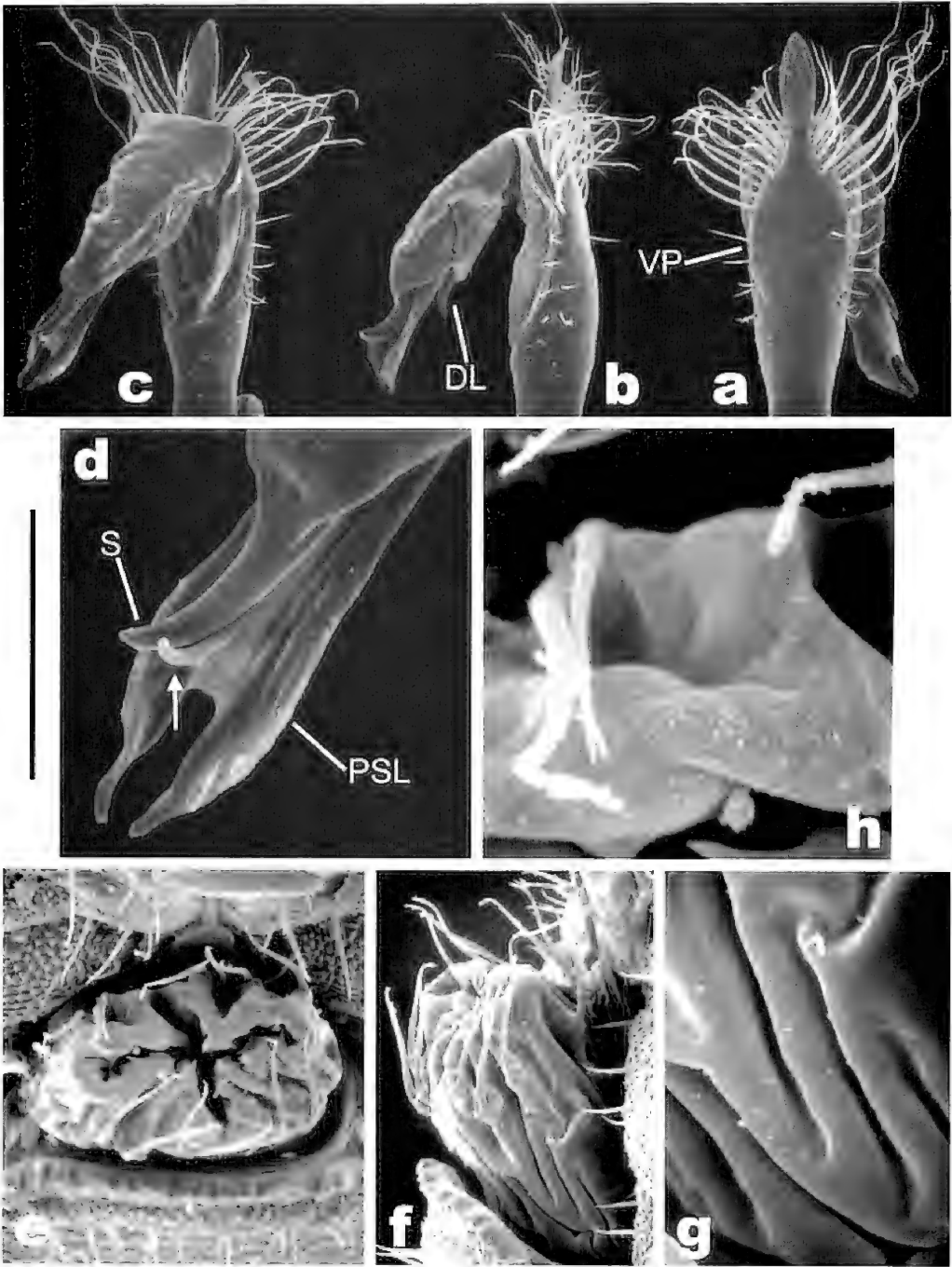


FIGURE 43. *Tularina scopula* (Briggs), genitalic morphology. a–d. Male, penis partially expanded in ventral (a), dexterolateral (b), and subdorsal (c) views, with ventroapical part of glans (d), showing stylus with tubule (arrow). e–h. Female, ovipositor in apical (e) and sinistrolateral (f) views, showing lateral surface of ovipositor lacking microspines (g), and bifid apical setae (h). DL = dorsal lobe, PSL = parastylar lobe, S = stylus, VP = ventral plate. Scale bar = 300 μ m (a–c), 180 μ m (e–f), 82 μ m (d), 57 μ m (g), 38 μ m (h).

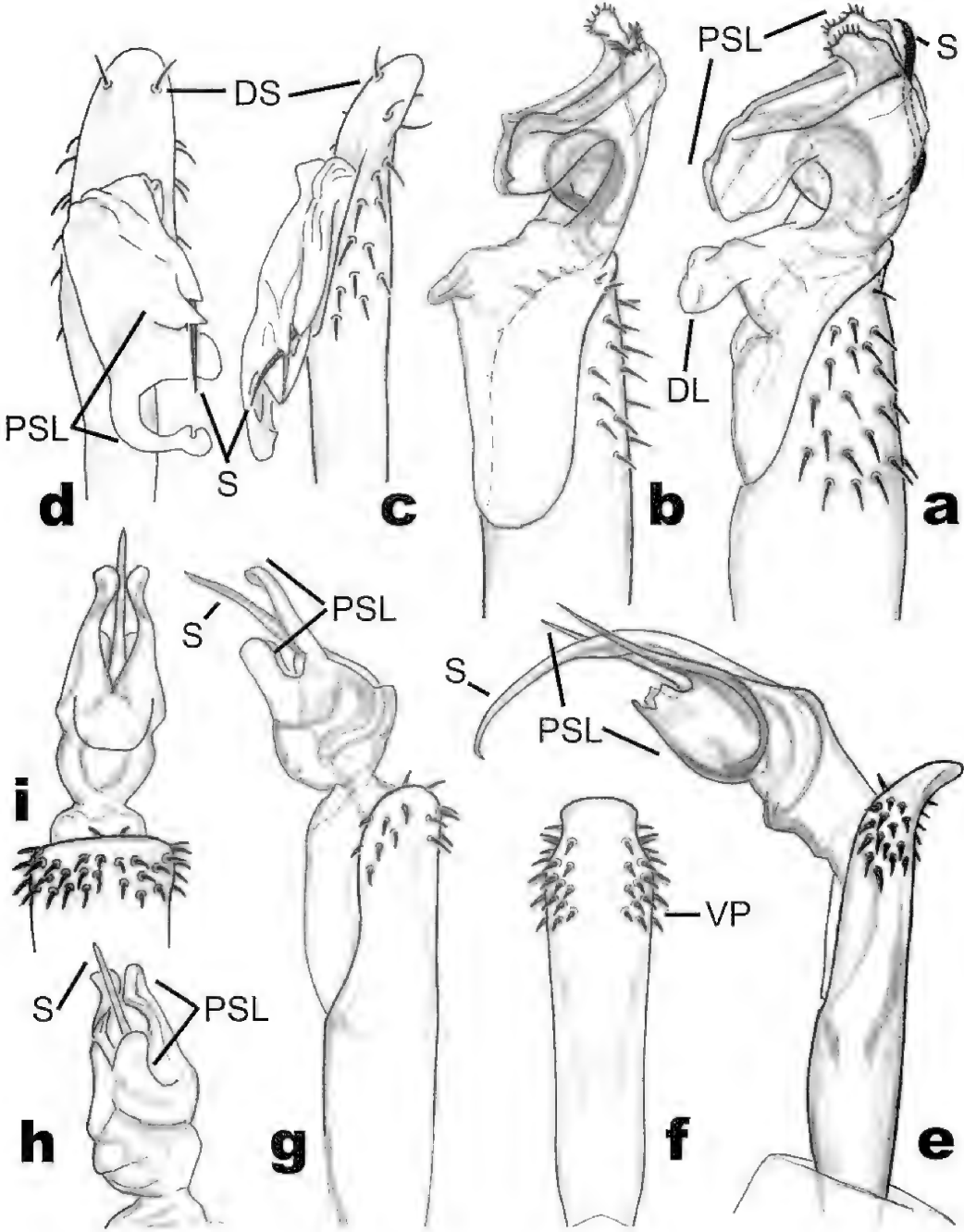


FIGURE 44. *Megacina* gen. nov., male genitalia. a–b. *M. cockerelli* (Goodnight and Goodnight), penis fully expanded in dexterolateral view with specimen from Crescent City (a) and Soda Rock Lane (b). c–d. *M. schusteri* sp. nov., penis unexpanded in dexterolateral (c) and dorsal (d) views. e–f. *M. mayaema* sp. nov., penis fully expanded in dexterolateral view (e) and truncus in ventral view (f). g–i. *M. madera* (Briggs), penis fully expanded in dexterolateral (g), dorsal (h), and ventral (i) views. DL = dorsal lobe, DS = dorsal seta, PSL = parastylar lobe, S = stylus, VP = ventral plate.

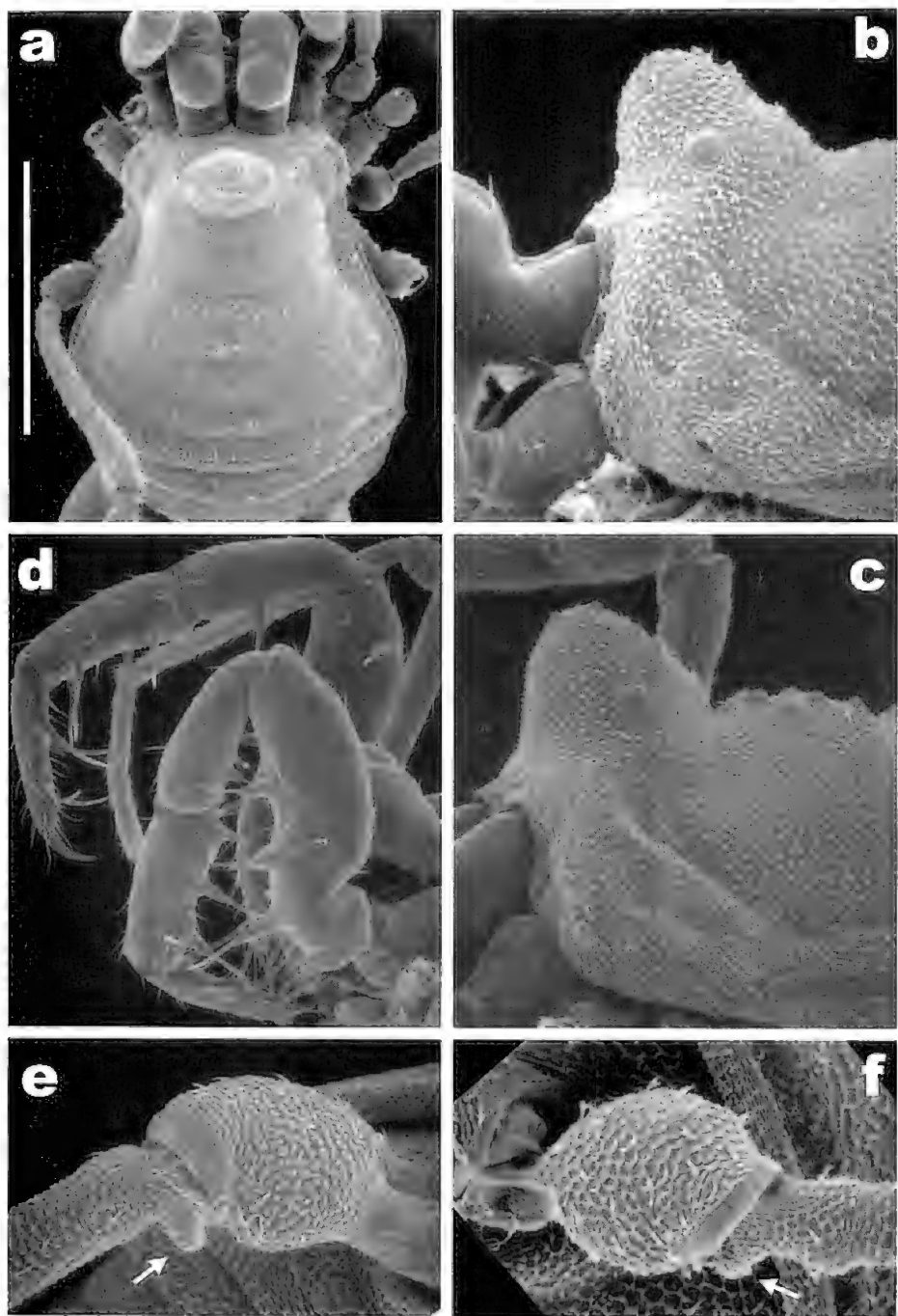


FIGURE 45. *Megacina madera* (Briggs), somatic morphology. a-b, f. Female. c-e. Male. a. Body, dorsal view. b-c. Cephalon, lateral view, showing areolate cuticle. d. Palpi, lateral view. e-f. Trochanter IV, ectal view, showing femoral processes (arrows). Scale bar = 720 μ m (a), 500 μ m (d), 330 μ m (e), 250 μ m (b, c), 190 μ m (f).

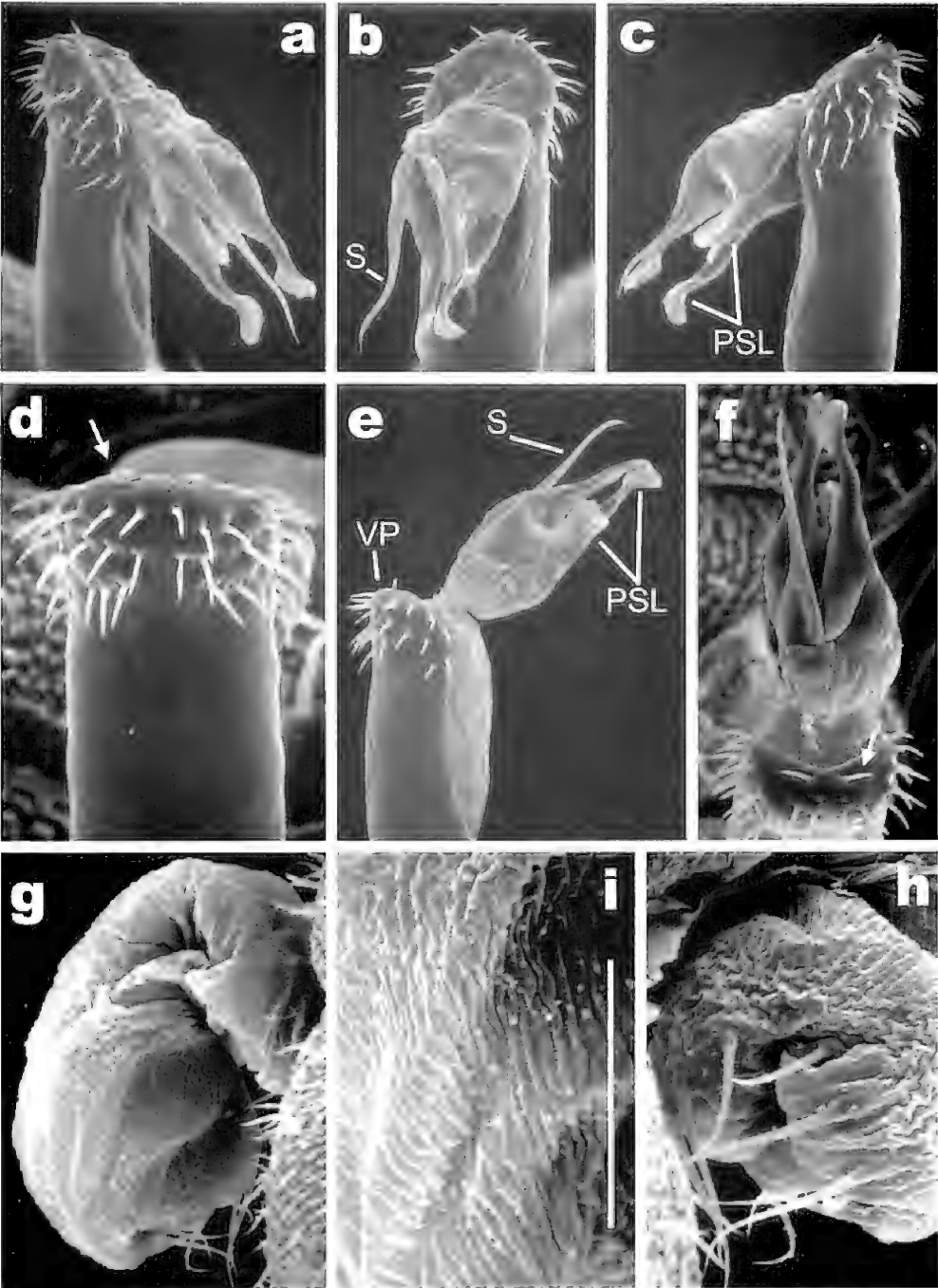


FIGURE 46. *Megacina maderae* (Briggs), genitalic morphology. a–f. Male, penis. a–c. Partially expanded, in sinistrolateral (a), dorsal (b), and dexterolateral (c) views. d–f. Fully expanded, in ventral (d), sinistrolateral (e), and apical (f) views, with arrows showing dorsal setae. g–i. Female, ovipositor, poorly expanded, in sinistrolateral (g) and dexterolateral (h) views, and lateral surface lacking microspines (i). PSL = parastylar lobe, S = stylus, VP = ventral plate. Scale bar = 140 μ m (g), 135 μ m (a–c, e), 115 μ m (f), 84 μ m (d), 82 μ m (h), 57 μ m (i).

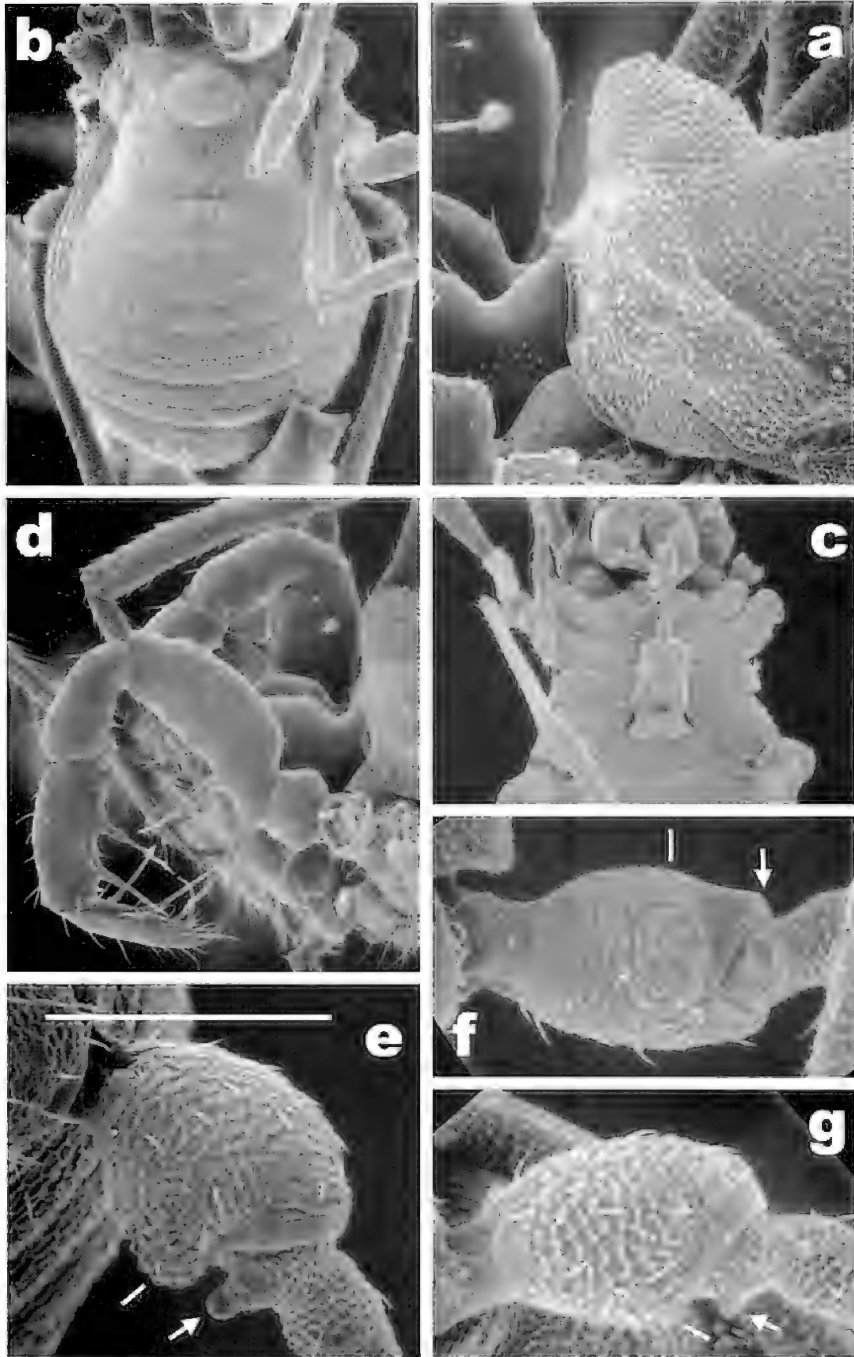


FIGURE 47. *Megacina schusteri* sp. nov., somatic morphology. a, b, g. Female. c, f. Male. a. Cephalon, lateral view, showing areolate cuticle. b–c. Body, dorsal (b) and ventral (c) views. d. Palpi, lateral view. e–g. Trochanter IV, in ectal (e, g) and ventral (f), views showing femoral process (arrow) and trochanteral swelling (line). Scale bar = 780 μ m (b–c), 450 μ m (d), 270 μ m (a), 180 μ m (e–g).

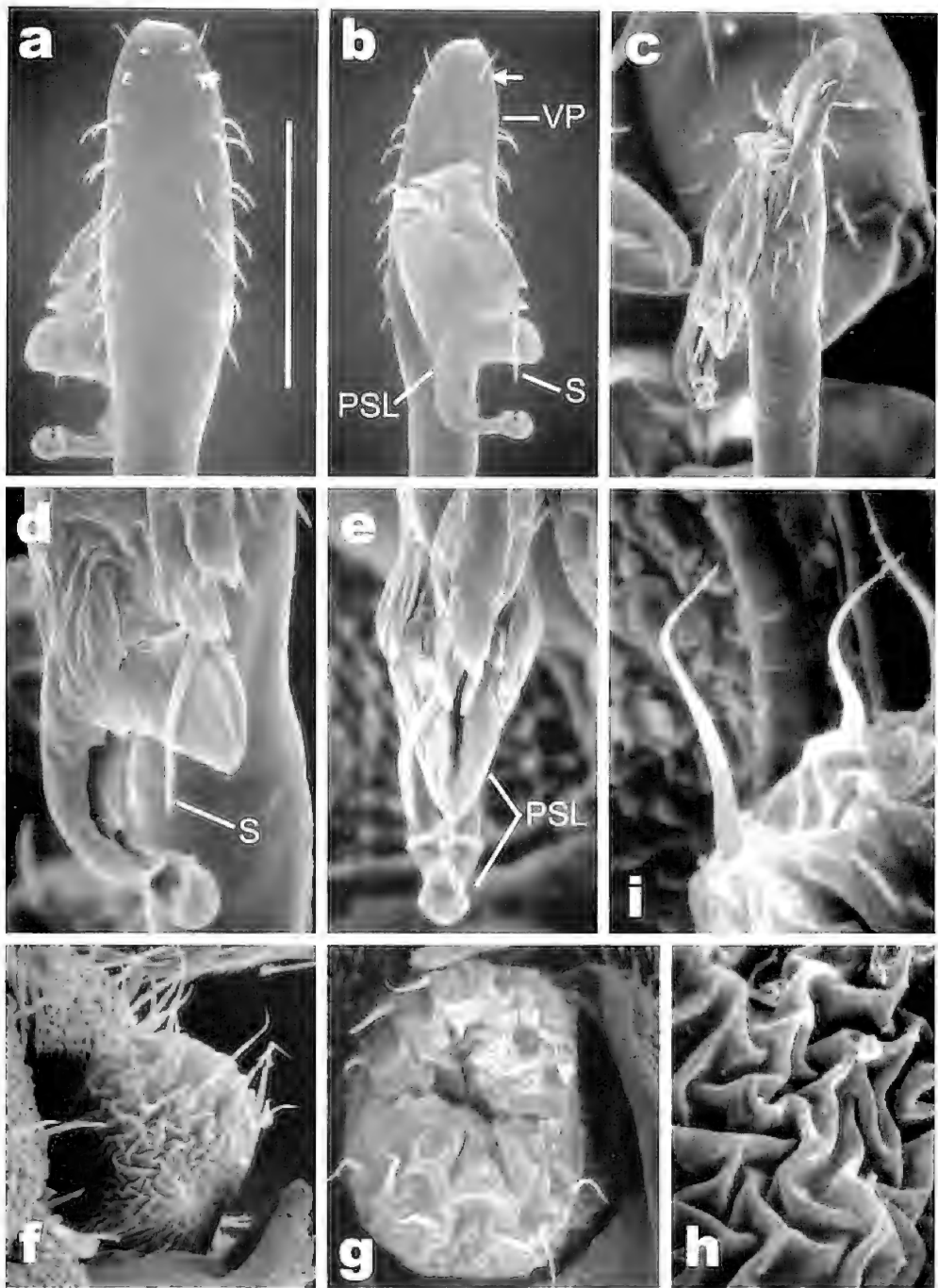


FIGURE 48. *Megacina schusteri* sp. nov., genitalic morphology. a–e. Male, penis unexpanded in ventral (a), dorsal (b), and dexterolateral (c) views, and distal half of glans in lateral (d) and ventral (e) views, with arrow showing dorsal seta. f–i. Female, ovipositor, in dexterolateral (f) and apical (g) views, with lateral surface lacking microspines (h), and close-up of apical setae (i). PSL = parastylar lobe, S = stylus, VP = ventral plate. Scale bar = 150 μ m (b–c), 145 μ m (f), 115 μ m (a, g), 57 μ m (d), 45 μ m (e), 38 μ m (h–i).

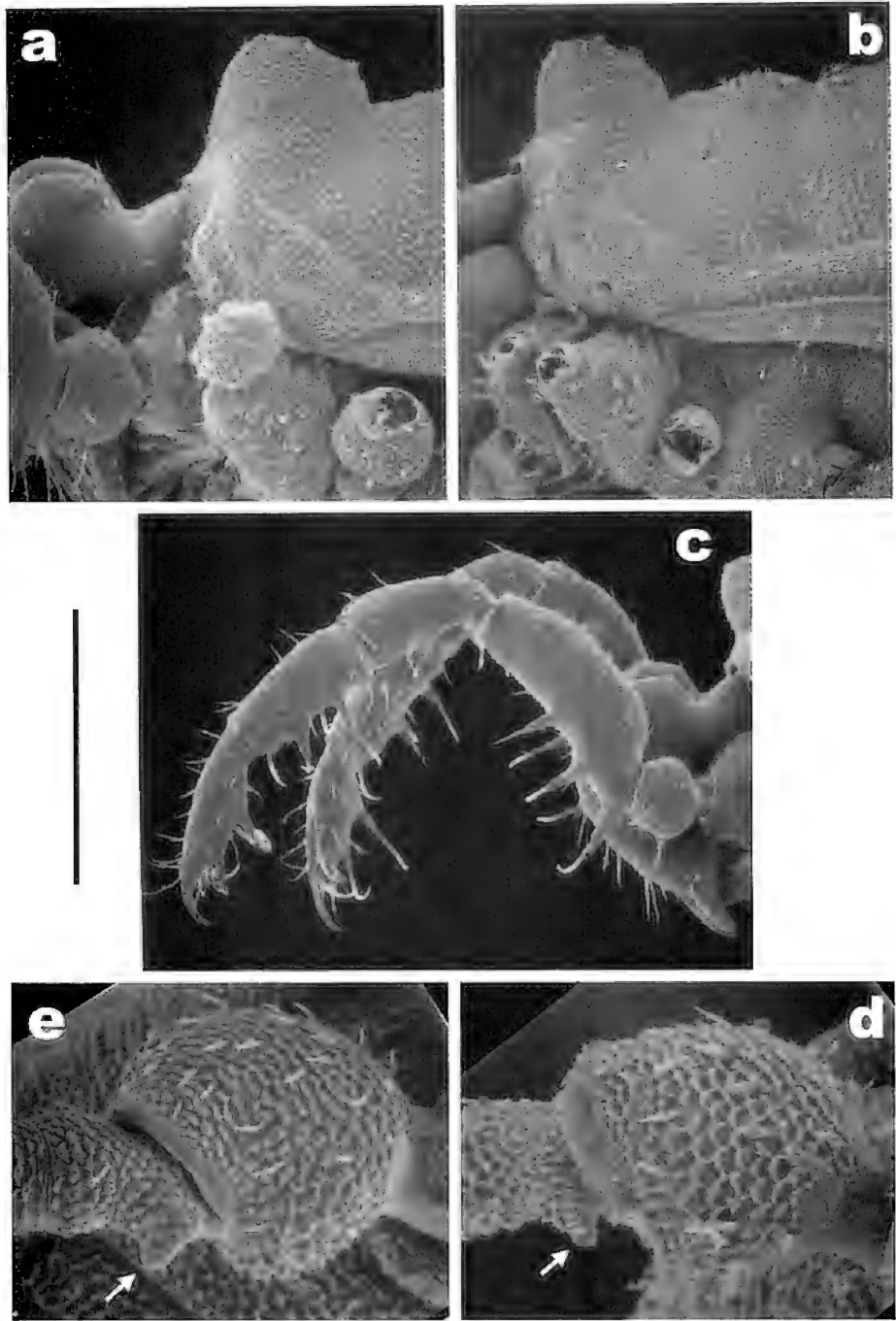


FIGURE 49. *Megacina mayacma* sp. nov., somatic morphology. a, e. Male. b–d. Female. a–b. Cephalon, lateral view showing areolate cuticle. c. Palpi, lateral view. d–e. Trochanter IV, in ectal view showing femoral process (arrows). Scale bar = 430 μ m (c), 350 μ m (a–b), 160 μ m (d–e).

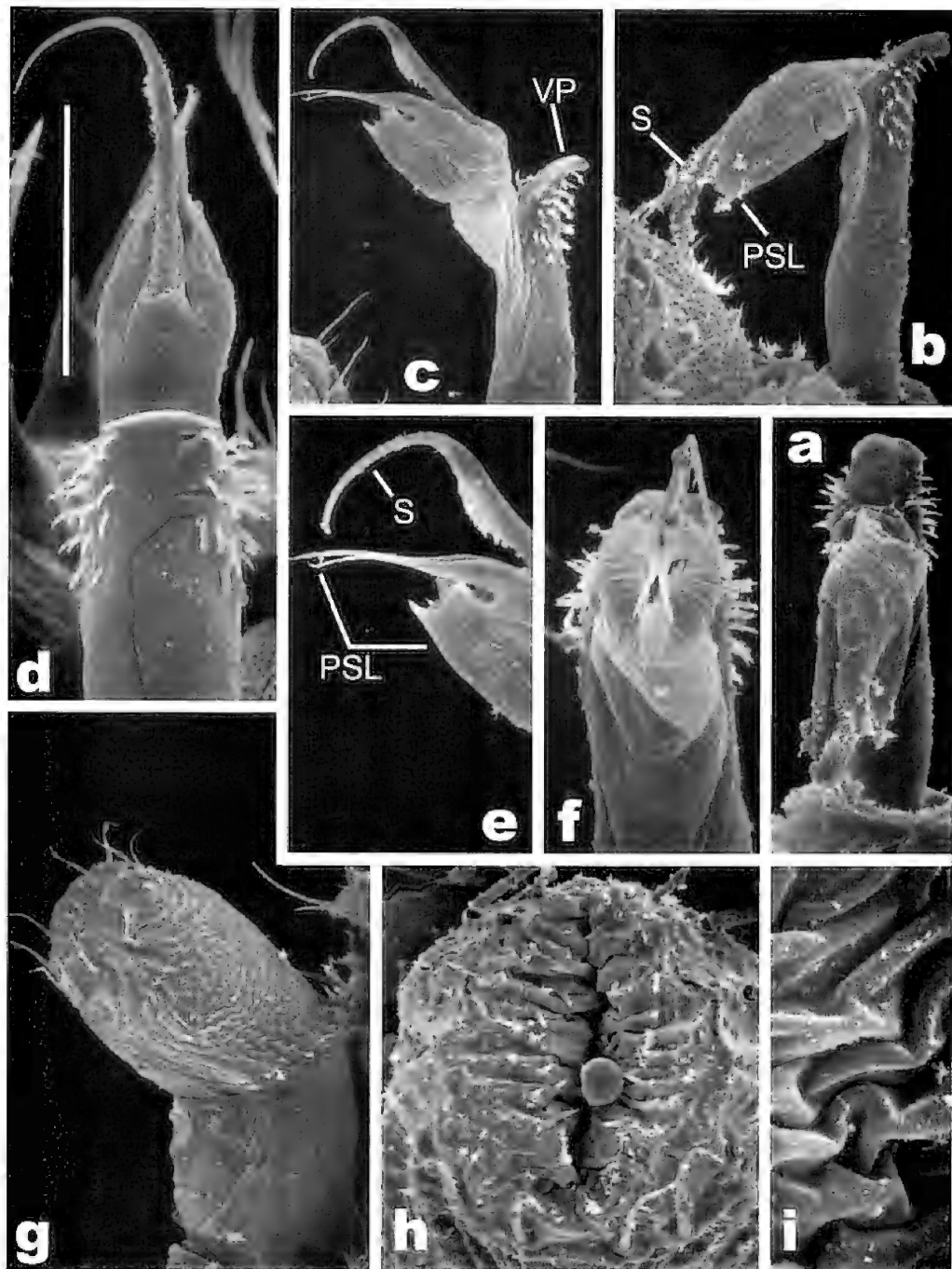


FIGURE 50. *Megacina mayacma* sp. nov., genitalie morphology. a–f. Male, penis, a–b. Partially expanded, in dorsal (a) and dexterolateral (b) views. c–f. Fully expanded, in dexterolateral (c, e), ventral (d), and dorsal (f) views. g–i. Female, ovipositor in sinistrolateral (g) and apical (h) views, with lateral surface lacking microspines (i). PSL = parastylar lobe, S = stylus, VP = ventral plate. Scale bar = 200 μ m (c), 190 μ m (a–b, g), 123 μ m (d), 115 μ m (e–f), 82 μ m (h), 19 μ m (i).

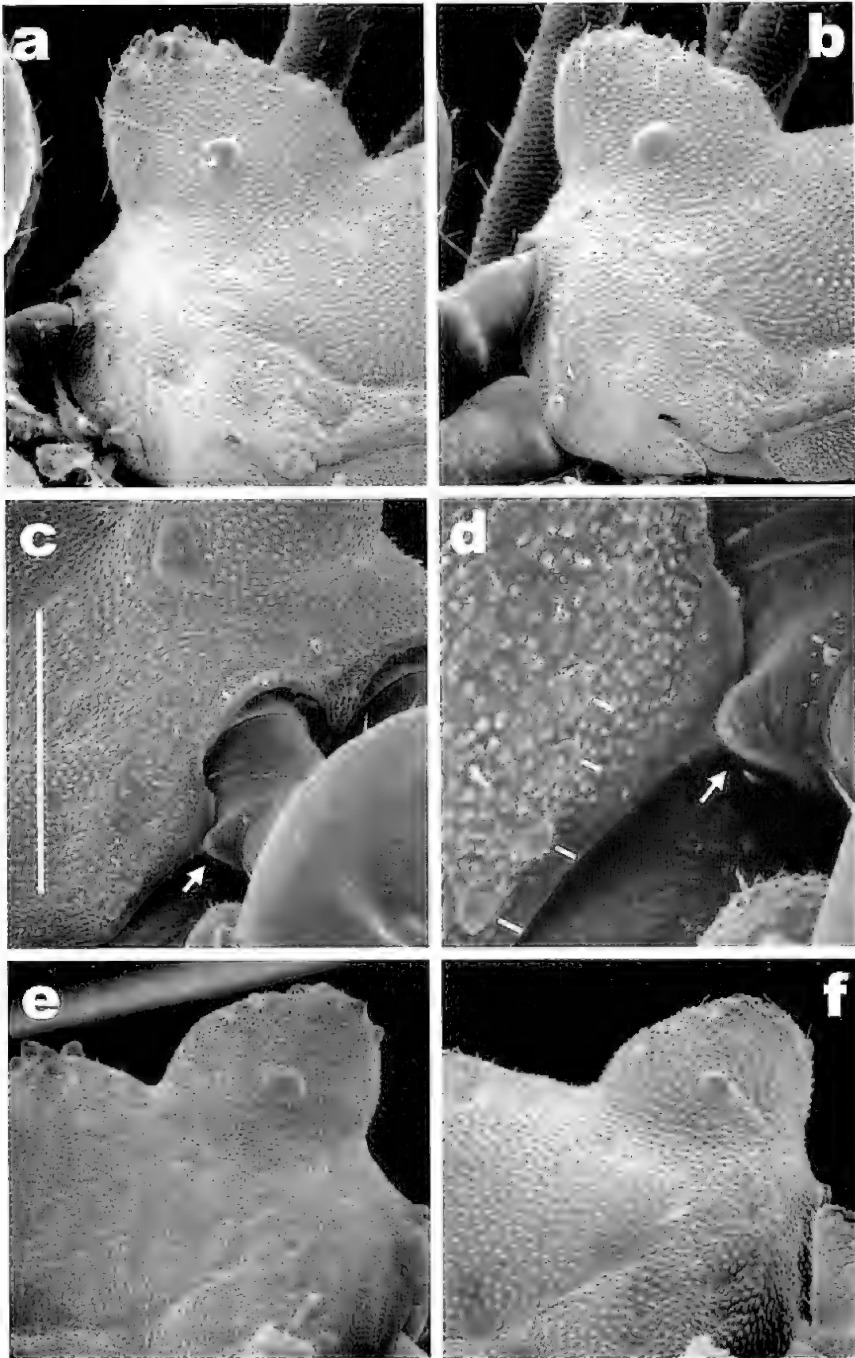


FIGURE 51. *Megacina cockerelli* (Goodnight and Goodnight), somatic morphology, cephalic region. a, c–e. Male. b, f. Female. a–b, e–f. Cephalon, lateral view. c–d. Cephalon, anteriolateral view, showing cheliceral boss (arrow) and AT (lines). N population: Boardman (a–b). Ft. Dick (c–d). S population: Burdell (e–f). Scale bar = 550 μ m (a, e), 450 μ m (b), 380 μ m (f), 360 μ m (c), 135 μ m (d).

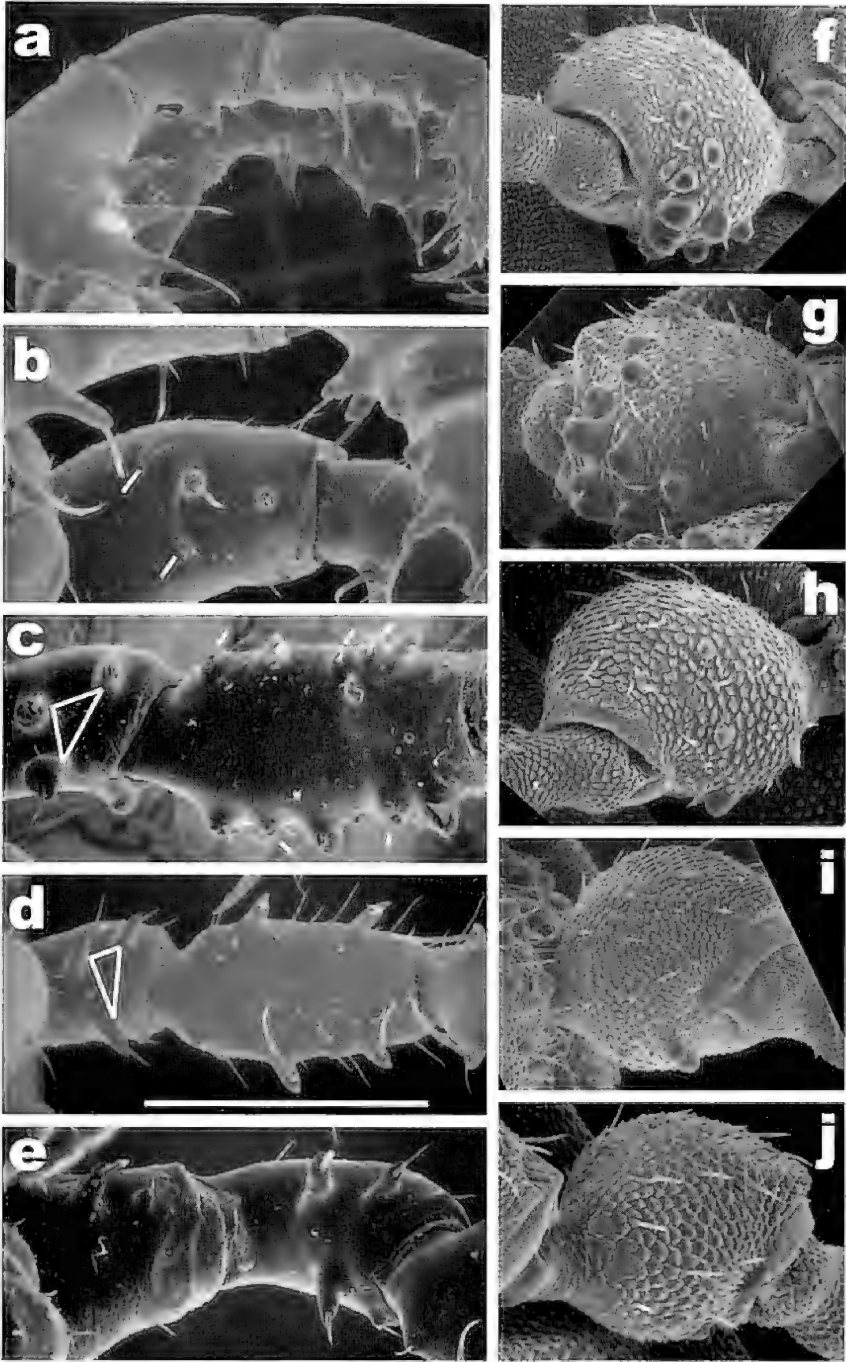


FIGURE 52. *Megacina cockerelli* (Goodnight and Goodnight), somatic morphology, appendages. a–c, f–g, i. Male. d–e, h, j. Female. a–e. Palpi. a. Palpi, lateroventral view. b. Palpal femur, mesoventral view showing additional tubercles (lines). c–d. Palpal tibia and patella, ventral view, with triangle showing arrangement of patellar megaspines in male (c) and female (d), and lines showing the additional tibial tubercles in male (c). e. Palpal patella and femur, ventral view. f–j. Trochanter IV in ventral (g) and lateral views (f, h–j). N population: Ft. Dick (b), Boardman (c–h). S population: Burdell (a, i–j). Scale bar = 780 μ m (a), 550 μ m (c–d), 460 μ m (f), 450 μ m (e), 375 μ m (g, i), 360 μ m (b), 315 μ m (h), 130 μ m (j).

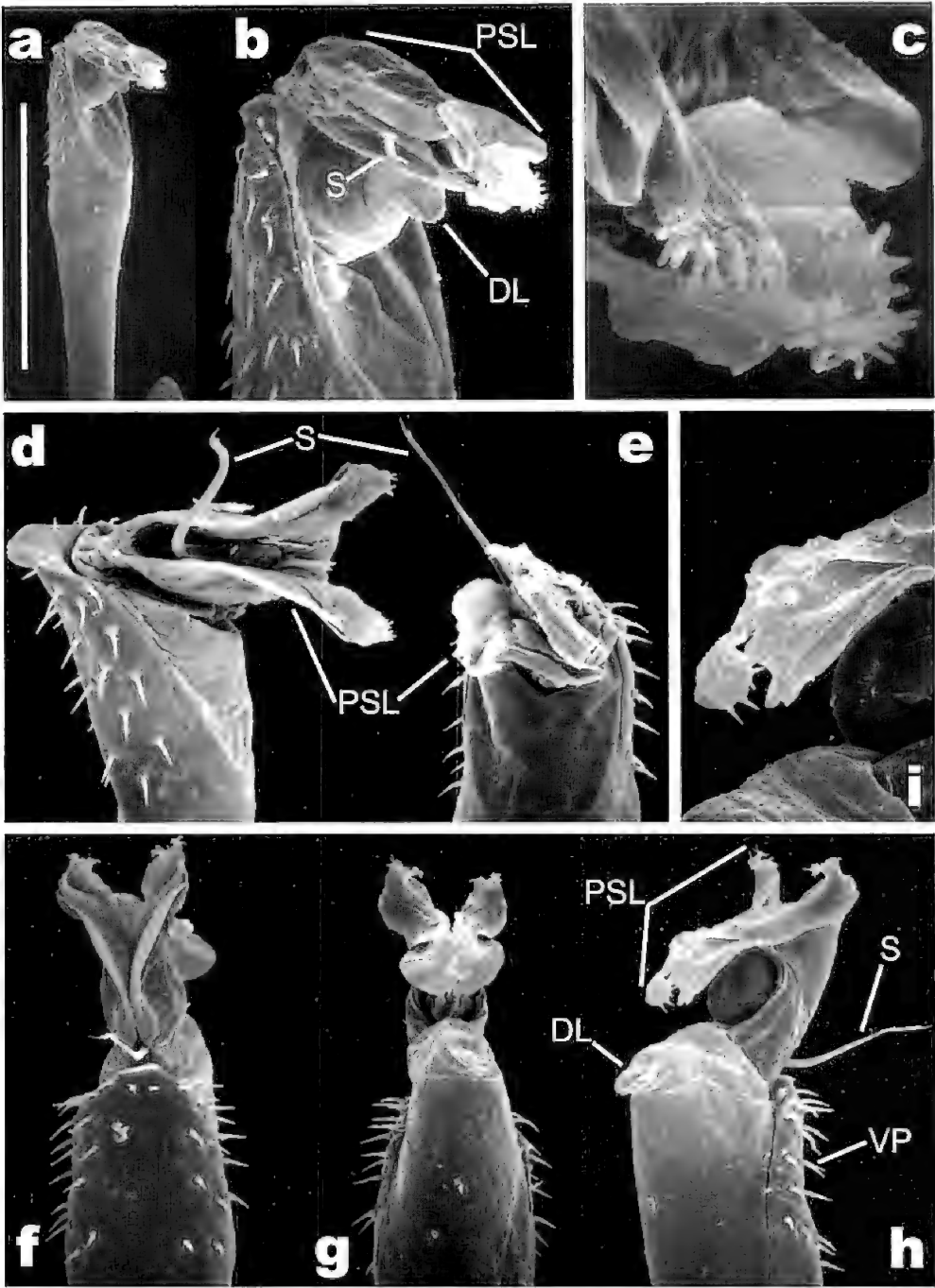


FIGURE 53. *Megacina cockerelli* (Goodnight and Goodnight), male genitalia. a-c. Penis with largely folded glans, dorso(sinistro)lateral view. d-e. Penis with partially expanded glans, in sinistrolateral (d) and dorsal (e) views. f-i. Penis with fully expanded glans in ventral (f), dorsal (g), and dexterolateral (h-i) views. N population: Ft. Dick (d-e), Boardman (a-c). S population: Soda Rock Lane (f-i). DL = dorsal lobe, PSL = parastylar lobe, S = stylus, VP = ventral plate. Scale bar = 380 μ m (a), 165 μ m (e-h), 145 μ m (b), 140 μ m (d), 75 μ m (i), 38 μ m (c).

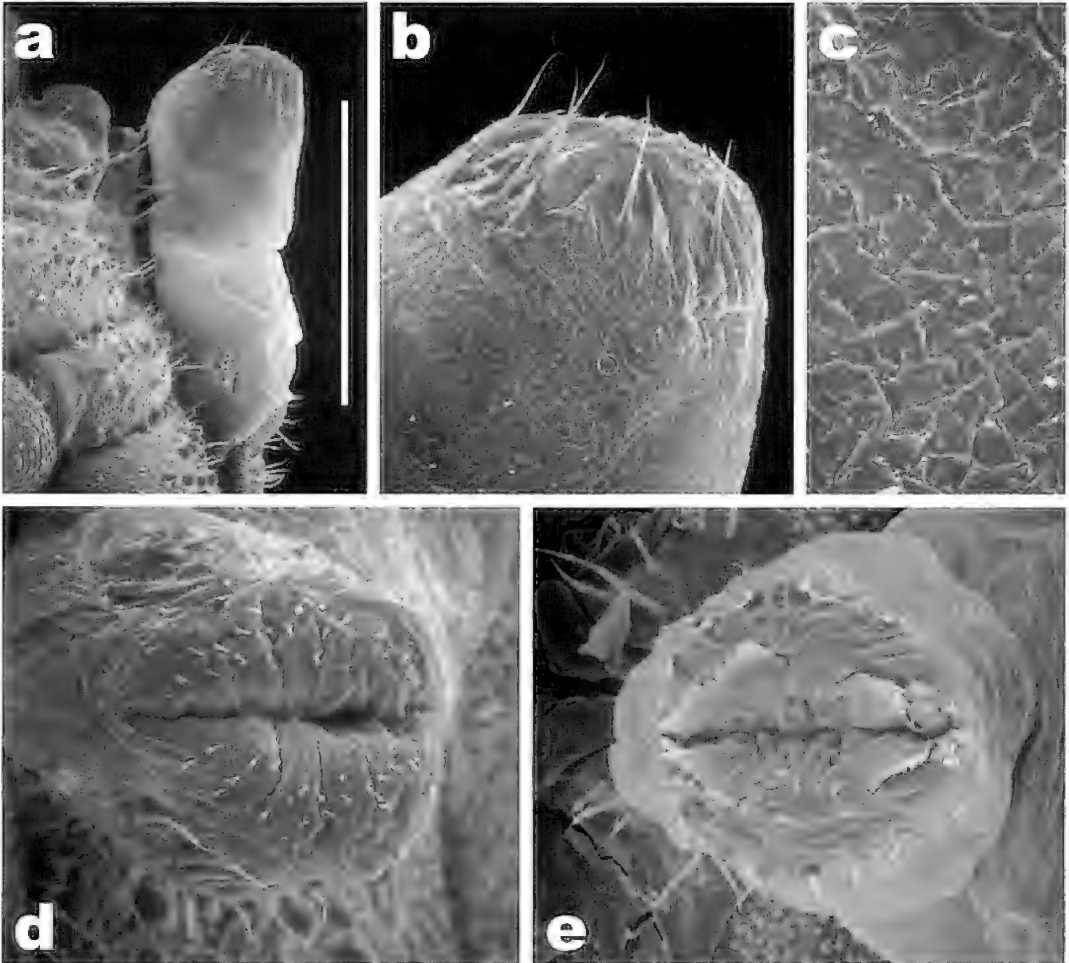


FIGURE 54. *Megacina cockerelli* (Goodnight and Goodnight), female genitalia. a–c. Ovipositor, dexterolateral view with apex showing setae (b) and lateral surface (c) showing absence of microspines. d–e. Ovipositor, apical view, clean (d) and with some sort of apical secretion (e). N population: Boardman (a–d). S population: Burdell (e). Scale bar = 570 μ m (a), 190 μ m (b, d–e), 60 μ m (c).

FIGURE 55. Character matrix and analysis of Nearctic Phalangodidae. X-axis. Taxa. Y-axis. Characters: male genitalia (# 1-14), female genitalia (# 15-19), somatic (#20-29). Matrix. 0 plesiomorphic, 1-4 derived states, ? not known, x not applicable.

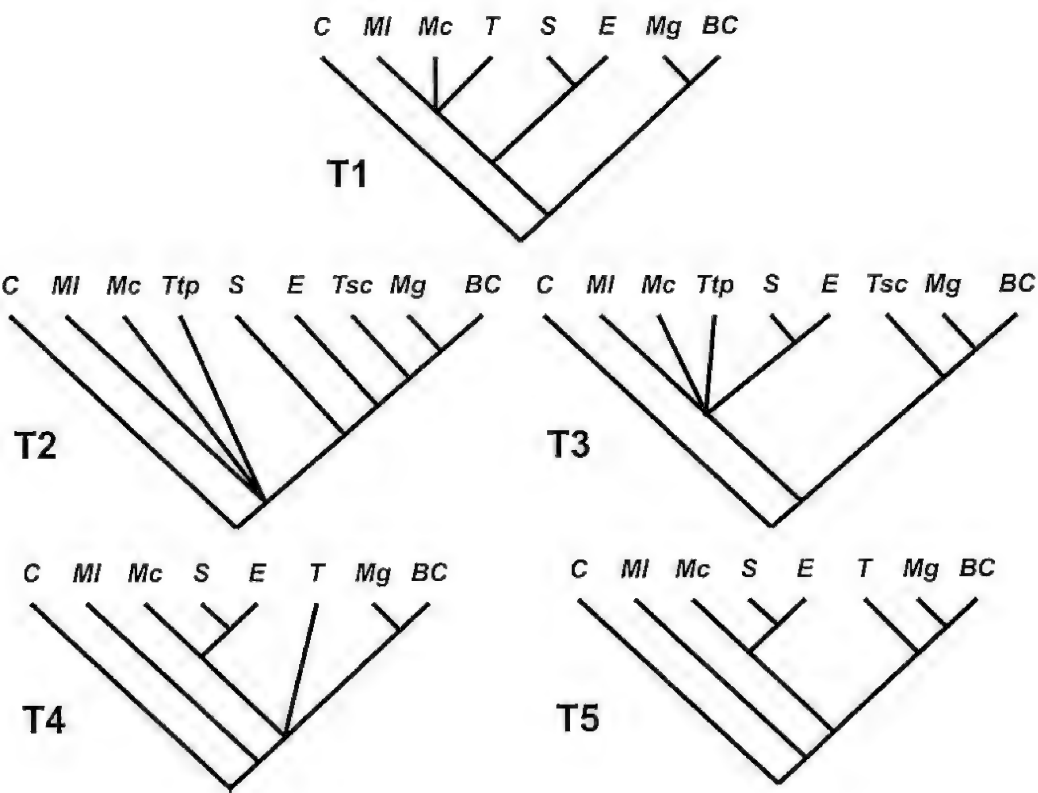


FIGURE 56. Cladograms of the Nearctic Phalangodidae, showing the five trees (T1-T5) discussed in the text. Abbreviations: BC = bifurcate clade, C = *Calicina* Ubick and Briggs, E = *Enigmina* gen. nov., Mc = *Microcina* Briggs and Ubick, Mg = *Megacina* gen. nov., MI = *Microcinella* gen. nov., S = *Sitalcina* Banks, T = *Tularina* gen. nov., Tsc = *Tularina scopula* (Briggs), Ttp = *Tularina plumosa* sp. nov. and *T. tularensis* sp. nov.

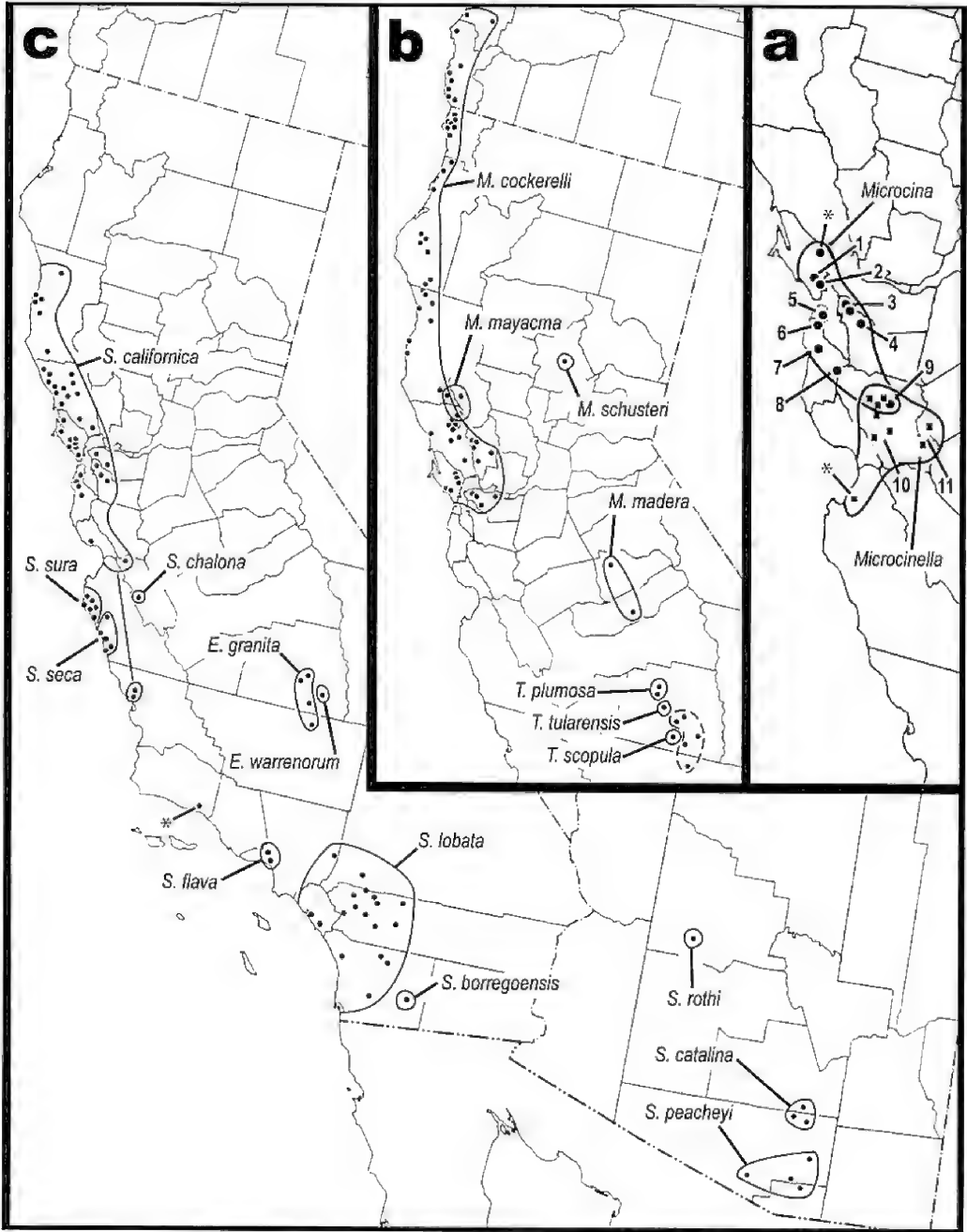


FIGURE 57. Maps of California and adjacent regions showing the distribution of species in the *Sitalcina* complex: **a:** (San Francisco Bay area) *Microcinella* gen. nov. (squares) and *Microcina* Briggs and Ubick (dots). *Microcina*: 1, *M. tamalpais* sp. nov.; 2, *M. tiburona* (Briggs and Hom); 3, *M. lee* Briggs and Ubick; 4, *M. lumi* Briggs and Ubick; 5, *M. potrero* sp. nov.; 6, *M. sanbruno* sp. nov.; 7, *M. edgewoodensis* Briggs and Ubick; 8, *M. stanford* sp. nov.; 9, *M. jungi* Briggs and Ubick; 10, *M. homi* (Briggs and Ubick); 11, *M. coensis* sp. nov. **b:** (Central California) *Tularina* gen. nov. and *Megacina* gen. nov. Area encircled by dashed line at bottom represents *Enigmima* gen. nov. (see also fig. c): **c:** (California and Arizona) *Sitalcina* Banks and *Enigmima* gen. nov. Undescribed new species are indicated by an asterisk.

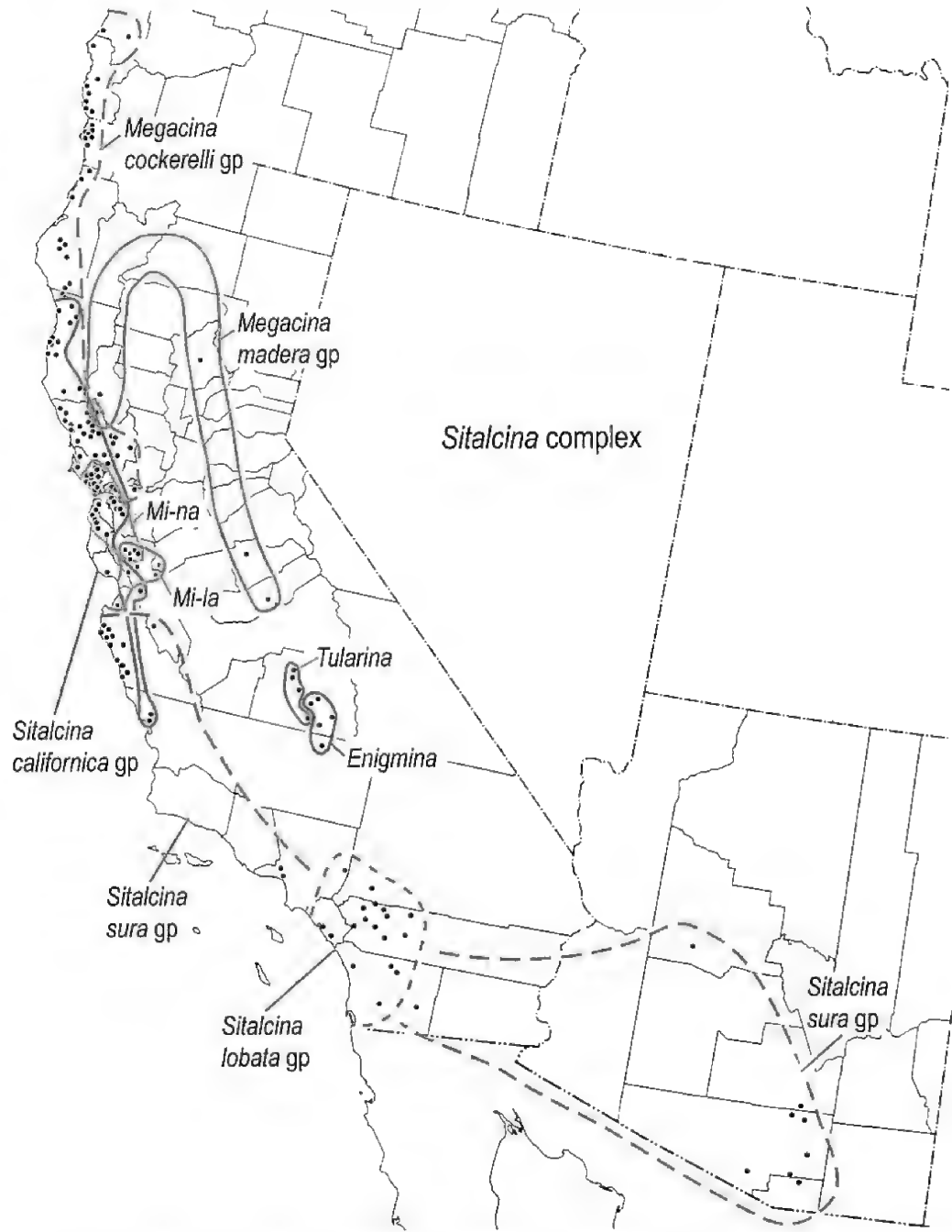


FIGURE 58. Map of California, Arizona and adjacent regions showing the distribution of genera and species groups of the *Sitalcina* complex. *Mi-la* = *Microcinella* gen. nov., *Mi-na* = *Microcina* Briggs and Ubick.

APPENDIX 1

Sitalcina complex: Classification and natural history

<i>Taxa</i> (bold = new)	<i>habitat</i>	<i>biome</i>
<i>Microcinella</i> gen. nov.		
<i>coensis</i> sp. nov.	serpentine	oak-chaparral
<i>homi</i> (Briggs and Ubick, 1989)	serpentine, sandstone	grassland
sp. (Monterey Co.)	sandstone	oak
<i>Microcina</i> Briggs and Ubick, 1989		
<i>edgewoodensis</i> Briggs and Ubick, 1989	serpentine	grassland
<i>jungi</i> Briggs and Ubick, 1989	serpentine	grassland
<i>leei</i> Briggs and Ubick, 1989	sandstone	oak-grassland
<i>lumi</i> Briggs and Ubick, 1989	serpentine	grassland
<i>potrero</i> sp. nov.	serpentine	<i>Eucalyptus</i> grassland
<i>sanbruno</i> sp. nov.	serpentine, sandstone	grassland, chaparral
<i>stanford</i> sp. nov.	basalt	grassland
<i>tamalpais</i> sp. nov.	basalt	forest-grassland ecotone
<i>tiburona</i> (Briggs and Hom, 1966)	serpentine	grassland
sp. (Marin Co.)	volcanic, sandstone	oak
<i>Sitalcina</i>		
<i>californica</i> group		
<i>californica</i> (Banks, 1893)	rocks, logs, duff, caves	oak, redwood, mixed forests
<i>sura</i> group		
<i>borregoensis</i> Briggs, 1968	granite	palm canyon
<i>chalone</i> Briggs, 1968	various rocks	broadleaf evergreen, chaparral
<i>flava</i> Briggs, 1968	sandstone	oak, oak-sycamore
<i>catalina</i> sp. nov.	caves, rocks, logs, duff	oak, +
<i>peacheyi</i> sp. nov.	caves, rocks, logs, duff	oak, +
<i>rothi</i> sp. nov.	?	?
<i>seca</i> sp. nov.	granite, logs, duff	broadleaf evergreen, redwood
<i>sura</i> Briggs, 1968	various rocks, logs, duff	redwood
sp. (Santa Barbara Co.)	rock	oak
<i>lobata</i> group		
<i>lobata</i> Goodnight and Goodnight, 1942	rocks, duff, <i>Neotoma</i> nests, tarantula burrows	oak, chaparral, pine, sycamore
<i>Enigmina</i> gen. nov.		
<i>granita</i> (Briggs, 1968)	granite	oak, oak-grassland
<i>warrenorum</i> sp. nov.	logs, duff	coniferous
<i>Tularina</i> gen. nov.		
<i>plumosa</i> sp. nov.	serpentine, granite	grassland
<i>scopula</i> (Briggs, 1968)	granite	grassland
<i>tularensis</i> sp. nov.	serpentine	grassland
<i>Megacina</i> gen. nov.		
<i>madera</i> group		
<i>madera</i> (Briggs, 1968)	serpentine, granite, wood	oak-yellow pine
<i>mayacina</i> sp. nov.	serpentine, logs	oak, pine
<i>schusteri</i> sp. nov.	meta-volcanic	oak-digger pine
<i>cockerelli</i> group		
<i>cockerelli</i> (Goodnight and Goodnight, 1942)	rocks, logs, duff	dense forests, oak-grassland, chaparral

A New *Ruellia* (Acanthaceae) from Guerrero, Mexico

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Two collections from the Río Balsas depression in northern Guerrero, Mexico are described as a new species, *Ruellia foliosepala*. Distinctive characteristics include pedunculate dichasia, broad calyx lobes, blue-purple chasmogamous corollas, and elongate capsules bearing 12 or more seeds. Differences between the two collections, including cleistogamy, likely reflect seasonal variation. Morphological variation in and probable infrageneric affinities of the species are noted.

Se describen dos colecciones de la depresión del Río Balsas en el norte de Guerrero, México como especie nueva, *Ruellia foliosepala*. Las características distintivas incluyen los dicasios pedunculados, los amplios lóbulos del cáliz, la corola de las flores casmógamas azul-purpúrea, y las cápsulas alargan que llevan 12 o más semillas. Las diferencias entre las dos colecciones, incluyendo la presencia de flores cleistógamas, probablemente reflejan la variación estacional. Se observan la variación morfológica y las afinidades infragéricas probablemente de la especie.

With some 250 species worldwide, *Ruellia* is among the most species rich genera of Acanthaceae. Although about 65 species are known from Mexico (Daniel 2004) several names attributed to the genus there remain to be placed. Taxonomy of the genus is complicated by interspecific hybridization (cf. Long 1970; Daniel 2007) and cleistogamy (often seasonal). Two collections of *Ruellia* from the Río Balsas depression in northern Guerrero do not conform to previously described taxa. Despite some differences in their respective inflorescences, they appear to pertain to the same taxon, which is described below. Recognition of this species brings the number of endemic species of Acanthaceae in the Río Balsas basin to 13 (cf. Daniel and Steinmann 2007).

Ruellia foliosepala T.F. Daniel, sp. nov.

TYPE.—MEXICO. **Guerrero:** Mpio. Buenavista de Cuéllar, 8 km NW de Iguala, camino Iguala—Taxco, 800 m, selva baja caducifolia, 6 July 1982, E. Martínez S. & J. Soto N. 1203 (holotype: MEXU!). Figure 1.

Herbae perennes usque ad 4 dm alti. Folia petiolata, laminae ovatae vel late ellipticae, 30–105 mm longae, 21–54 mm latae, 1.2–2.4-plo longiores quam latiores. Dichasia in axillis foliorum vel bractearum foliacearum pedunculata. Bracteolae lineari-ellipticae vel oblanceolatae, 4–10 mm longae, 0.7–2 mm latae. Flores pedicellati pedicellis 3–30 mm longis; calyx 13–21 mm longus lobis ovatis vel ellipticis, 4–6 mm latis; corolla caeruleo-purpurea, 39–45 mm longa, extus trichomatibus eglandulosis. Capsula lineari-ellipsoidea vel lineari-obovoidea, 13.5–18 mm longa, pubescens non nisi apice trichomatibus eglandulosis. Semina 12 vel plus in capsula, paginis et margine pubescenti trichomatibus hygroscopicis.

Perennial herbs to 4 dm tall with numerous turgid but non-tuberous roots. Young stems quadrate-sulcate to quadrate-flattened, \pm evenly pubescent with a conspicuous overstory of flexuose eglandular trichomes 0.5–2.3 mm long and an inconspicuous understory of sparse retrorse to retrorsely appressed sometimes bifariously disposed eglandular trichomes to 0.3 mm long. Leaves petiolate, petioles to 25 mm long, blades ovate to broadly elliptic, 30–105 mm long, 21–54 mm wide, 1.2–2.4 times longer than wide, rounded to acute at apex, \pm abruptly acute to subattenuate at base, surfaces pubescent with eglandular trichomes, margins sinuate-crenate. Inflorescence of pedunculate dichasia borne in leaf axils or of subsessile dichasia borne in axils of reduced distal leaves (bracts) forming a \pm dense terminal headlike thyrse; dichasia opposite or alternate, 1 per axil, 1–3 (or more)-flowered, peduncles 2–20 mm long, pubescent like young stems or with overstory trichomes sparser and understory trichomes denser. Bracts (if present) petiolate, elliptic, 18 mm long, 6 mm wide, pubescent like leaves. Bracteoles and secondary bracteoles linear-elliptic to oblanceolate, 4–10 mm long, 0.7–2 mm wide, abaxial surface pubescent with flexuose eglandular trichomes to 1 mm long. Flowers pedicellate, pedicels 3–30 mm long, pubescent like peduncles. Calyx 5-lobed, 13–21 mm long, lobes ovate to elliptic, 12–18 mm long, subequal in length, 4–6 mm wide, abaxially pubescent with flexuose eglandular trichomes 0.3–1.2 mm long, margin ciliate with mostly flexuose eglandular trichomes 0.5–1.5 mm long. Corolla blue-purple, 39–45 mm long, externally pubescent with flexuose eglandular trichomes 0.1–0.5 mm long, tube 26–33 mm long, narrow proximal portion 10–11 mm long, abruptly expanded distally into a distinct throat, throat 13–21 mm long, longer than narrow proximal portion of tube, 6.5–9.5 mm in diameter near midpoint, limb 28–37 mm in diameter, lobes 13–15 mm long, 11–16 mm wide. Stamens included, didynamous, presented at 2 heights in throat, longer pair 10–11 mm long, shorter pair 7–8 mm long, filaments glabrous, thecae 3.5–3.7 mm long, glabrous. Style 19 mm long, glabrous distally, proximal portion not seen. Capsule linear-ellipsoid to linear-obovoid, 13.5–18 mm long, pubescent at apex only with erect to flexuose eglandular trichomes 0.2–0.6 mm long, stipe 1.5–2 mm long. Seeds 12 or more per capsule, (2–) 2.5–2.7 mm long, (1.5–) 2–2.2 mm wide, surfaces and margin covered with appressed hygroscopic trichomes.

PHENOLOGY.— Flowering: July (chasmogamous), September (cleistogamous); fruiting: July–September.

DISTRIBUTION AND HABITAT.— Endemic to Mexico, plants occur in Guerrero (Fig. 2b) in tropical deciduous forest at elevations of 630–800 m.

PARATYPE.— MEXICO. **Guerrero:** Mpio. Tepecoacuilco de Trujano, San Miguel Tecuicapan, entre Los Amates afueras (Cerro Tepeyehualco), pie del Cerro Tepeyehualco, 7 km NNE de San Miguel, 18°01'N, 99°24'W, *J. Amith & G. Hall 878* (CAS).

The two known collections of this species occur about 50 km apart on the northern slope of the Río Balsas. Although both exhibit the characteristic calyx, capsule, and seeds, they differ in several features. *Amith & Hall 878* differs from the type by having terminal, headlike clusters of subsessile multi-flowered dichasia (vs. single-flowered, long-pedunculate dichasia from leaf axils) and capsules with 12 (vs. more than 16) seeds. An axillary, long-pedunculate dichasium is present on *Amith & Hall 878* proximal to the terminal cluster. This putative difference in inflorescence structure might be related to the flowering season. *Amith & Hall 878* was collected later in the season when chasmogamous flowers were not present. The cleistogamous flowers present on that collection are budlike and 4.5 mm long. The triaperturate pollen with a coarsely reticulate exine (Fig. 2a) is similar to most other species of *Ruellia* for which pollen has been reported (Daniel 1998).

Like many species of *Ruellia* the infrageneric affinities of *R. foliosepala* remain unclear. Using Lindau's (1895) provisional infrageneric classification of the genus, *R. foliosepala* would likely be included in section *Ruellia* (as "*Eruellia*") because of its linear-ellipsoid capsule and infundibuli-

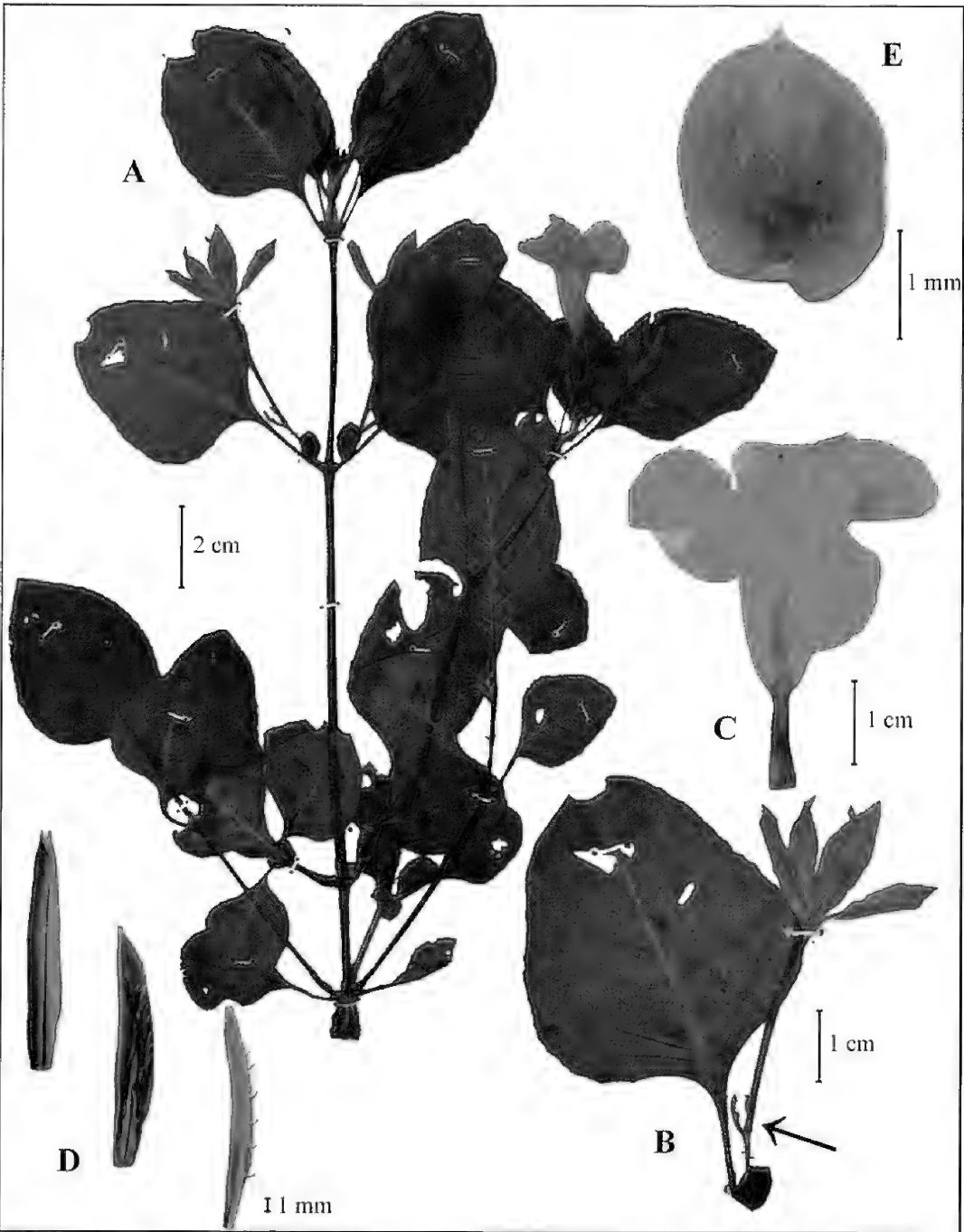


FIGURE 1. *Ruellia foliosepala* (Martinez S. & Soto N. 1203). A. Habit. B. Leaf subtending peduncle, bracteoles (arrow), and calyx. C. Corolla. D. Capsules, exterior at left, interior at center, profile at right. E. Seed.

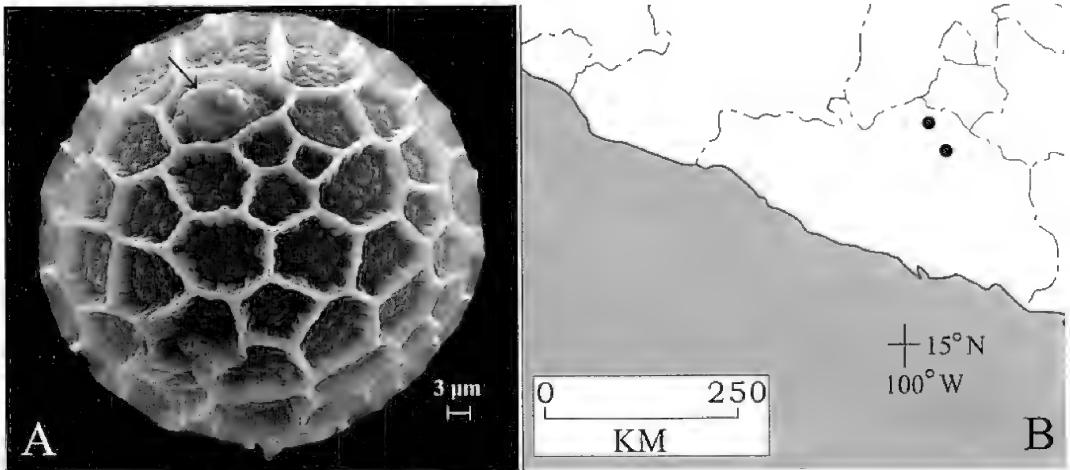


FIGURE 2. Pollen (Martínez S. & Soto N. 1203) and distribution of *Ruellia foliosepala*. A. Pollen showing one aperture (arrow). B. Portion of southern coastal Mexico showing distribution in northern Guerrero.

form corolla with a relatively short and cylindric narrow proximal portion of the tube. Among the informal taxonomic groups of *Ruellia* recognized for southern South American taxa by Ezcurra (1993) *R. foliosepala* corresponds to her “group *Ruellia*.” Based on nuclear and chloroplast DNA sequences of a large sample of *Ruellia*, Tripp (2007) produced a phylogeny of the genus in which several New World lineages were recovered, including one that pertains to Lindau’s section *Ruellia* and Ezcurra’s “group *Ruellia*.” Characters noted by Tripp (2007) for species in this lineage (as “*Euruellia*”) generally correspond to those of *R. foliosepala*. If the species does pertain to this section/lineage, relatives in Mexico include *R. lactea* Cav., *R. nudiflora* (Engelm. & A. Gray) Urb., and *R. coerulea* Morong.

ACKNOWLEDGMENTS

I am grateful to Jonathan Amith for sending collections of Acanthaceae (including this species) from his ethnobotanical studies in Mexico; the staffs of ENCB, IBEG, MEXU, MICH, MO and US for loans of *Ruellia*; and Scott Serata for assistance with scanning electron microscopy at CAS.

LITERATURE CITED

- DANIEL, T.F. 1998. Pollen morphology of Mexican Acanthaceae: diversity and systematic significance. *Proceedings of the California Academy of Sciences*, ser. 4, 50:217–256.
- DANIEL, T.F. 2004. Acanthaceae of Sonora: taxonomy and phytogeography. *Proceedings of the California Academy of Sciences*, ser. 4, 55:690–805.
- DANIEL, T.F. 2007. Artificial interspecific hybridization of two Mexican species of *Ruellia* (Acanthaceae). *Contributions from the University of Michigan Herbarium* 25:191–197.
- DANIEL, T.F. AND V.W. STEINMANN. 2007. Two new species of *Justicia* (Acanthaceae) from the Río Balsas basin of Michoacán, Mexico. *Contributions from the University of Michigan Herbarium* 25:199–205.
- EZCURRA, C. 1993. Systematics of *Ruellia* (Acanthaceae) in southern South America. *Annals of the Missouri Botanical Garden* 80:787–845.
- LINDAU, G. 1895. Acanthaceae. Pages 274–354 in A. Engler and K. Prantl, eds., *Die Natürlichen Pflanzenfamilien*, vol. 4. W. Engelmann, Leipzig.
- LONG, R.W. 1970. The genera of Acanthaceae in the southeastern United States. *Journal of the Arnold Arboretum* 51:257–309.
- TRIPP, E.A. 2007. Evolutionary relationships within the species-rich genus *Ruellia* (Acanthaceae). *Systematic Botany* 32:628–649.

***Trachyscorpia osheri* and *Idiastion hageyi*, Two New Species of Deepwater Scorpionfishes (Scorpaeniformes: Sebastidae, Scorpaenidae) from the Galápagos Islands**

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Trachyscorpia osheri species novum, is described from two specimens collected off Isla Fernandina and Isla Darwin, Galápagos Islands, using a manned submersible in 402–515 m. It is referred to the subgenus *Trachyscorpia* and differs from all known congeners in having 12 dorsal spines, 25 vertebrae, an arched dorsal profile, minute dorsal spines, and in lacking a swimbladder. *Idiastion hageyi* species novum, is described from a single specimen also collected off Isla Fernandina, in 522 m. It differs from its two congeners in having fewer pored lateral-line scales, five anal-soft rays, a deeper body, and a smaller orbit.

More than 30 new species of fishes were collected from the Galápagos Archipelago using the manned submersible *Johnson Sea-Link* in 1995 (McCosker 1997). Various authors have already described many of those taxa and I herein take pleasure in describing two remarkable deepwater scorpionfishes that were collected in the archipelago. Additional new scorpionfishes remain to be discovered in deepwater in the eastern Pacific and manned submersible usage will certainly make that possible.

Research undertaken by California Academy of Sciences scientists would not be possible were it not for the generous support of federal agencies, corporations, and philanthropic individuals. It is with particular pride and pleasure that I describe these two remarkable new species in honor of two very generous individuals, Bernard A. Osher and Harry R. Hagey.

MATERIALS AND METHODS

Counts and measurements follow Motomura (2004) and Motomura et al. (2007). Terminology of head spines follows that of Randall and Eschmeyer (2001). Measurements are straight-line and made with dial calipers or dividers and recorded to the nearest 0.1 mm. Proportions are expressed in terms of standard length (SL) or head length (HL). The last two soft rays of the median fins are counted as single rays, as each pair is associated with a single pterygiophore. Pectoral-fin ray counts begin with the uppermost ray. The interorbital width is the least bony width. Lengths of regenerated or broken spines were not measured. Gill arch description is based on the first right gill arch of each holotype, which was removed. Osteological characters were observed and fin ray counts were made from radiographs. Institutional abbreviations follow Leviton et al. (1985).

FAMILY SEBASTIDAE

Trachyscorpia osheri McCosker, sp. nov.

Galápagos Thornyhead

Figures 1–3

MATERIAL EXAMINED.— HOLOTYPE: CAS 86509, 147 mm SL, sex undetermined, Islas Galápagos, Isla Darwin, 01°42.05'N, 92°00.02'W, suction-captured from the submersible *Johnson Sea-Link* (JSL Dive 3967) at 515 m by J.E. McCosker and party on 21 Nov. 1995. Paratype: CAS 86504, 135 mm SL, sex undetermined, Islas Galápagos, Isla Fernandina, Cabo Douglas, 00°17.53'N, 91°38.35'W, suction-captured from the submersible *Johnson Sea-Link* (JSL Dive 3957) at 402–451 m by J.E. McCosker and party on 16 Nov. 1995.

DIAGNOSIS.— A species of *Trachyscorpia*, subgenus *Trachyscorpia*, with the following characteristics: dorsal-fin rays XII-9; vertebrae 25; tympanic spines present; upper-jaw lip well developed, covering most of premaxillary band laterally; no scales on lateral surface of maxilla; ~59–60 scale rows in longitudinal series; second pelvic fin ray the longest; pectoral fin deeply notched, length of 11th ray 65% of that of 17th ray; body deep (depth 37–39% SL); orbit diameter large (14–15% SL); head profile slightly convex; swimbladder absent; coloration reddish, with white markings and black markings and smudges on portions of head, dorsal surface of flanks and fins.

DESCRIPTION.— Proportional measurements are given as percentages of SL in Table 1. The following description is based on the holotype (Figs. 1–2), with the data for the paratype (Fig. 3), if different, in parentheses. Dorsal fin with 12 spines and 9 soft rays; all soft rays branched; length of first spine 1.6 (1.2) in second spine, 2.6 in third spine; length of third spine slightly more than orbit diameter; fourth to eleventh spines progressively shorter; length of twelfth spine 1.5 (1.7) that of eleventh; membrane of spinous portion of dorsal fin moderately notched; posterior branch of last dorsal soft ray joined by membrane to caudal-fin peduncle for less than one-fifth of its length. Anal fin with 3 spines and 5 (6) soft rays; all soft rays branched; second and third spines much longer than first; first soft ray longest, its length slightly longer than that of second anal-fin spine; posterior branch of last soft ray joined by membrane to caudal-fin peduncle for less than one-fourth of its length. Pectoral fins with 23 (22) rays on each side, the uppermost ray unbranched, remaining rays branched; second to fourth rays longest; posterior margin of fin bilobed, first to sixth rays progressively longer in length, then shorter to twelfth to fourteenth, then increasing in length; rays in lower lobe thickened, fleshy. Pelvic fin with 1 spine and 5 soft rays, all soft rays branched; entire first to third rays and base of fourth and fifth rays covered with thick fleshy skin; second soft ray longest, its length slightly shorter than upper-jaw length. Caudal fin with 18 segmented rays, 13 branched rays, the upper and lower 3 rays unbranched; dorsal procurent rays 4 (5), ventral rays 5; posterior margin of fin nearly straight. Caudal-peduncle depth 1.7 (1.9) in caudal-peduncle length.

Scale rows in longitudinal series ~60 (~59). Pored lateral-line scales ~24 (22). Scales below lateral line 11 (12). Scale rows between base of sixth dorsal-fin spine and lateral line 10. Predorsal scale rows ~14 (12). Gill rakers on upper limb 5, on lower limb 11; total gill rakers 16. Gill rakers relatively short and spinous with numerous minute serrae, longest raker on first gill arch slightly shorter than gill filaments around angle of gill arch; a small slit behind the fourth gill arch. Approximately 25 pseudobranchial filaments. Swimbladder absent. Branchiostegal rays 6. Vertebrae 25.

Body moderately compressed anteriorly, progressively more compressed posteriorly. Nape and anterior body not strongly arched. Body relatively deep, its depth slightly less than head length. No distinct small papillae on head. Three short, slender tentacles on dorsal margin of eye membrane. No distinct tentacles on posterior ends of preocular, supraocular and postocular spine bases. A pair of short tentacles on posterodorsal edge of low membranous tube associated with anterior nostril; length of tentacle equal to anterior nostril height. No tentacles associated with posterior

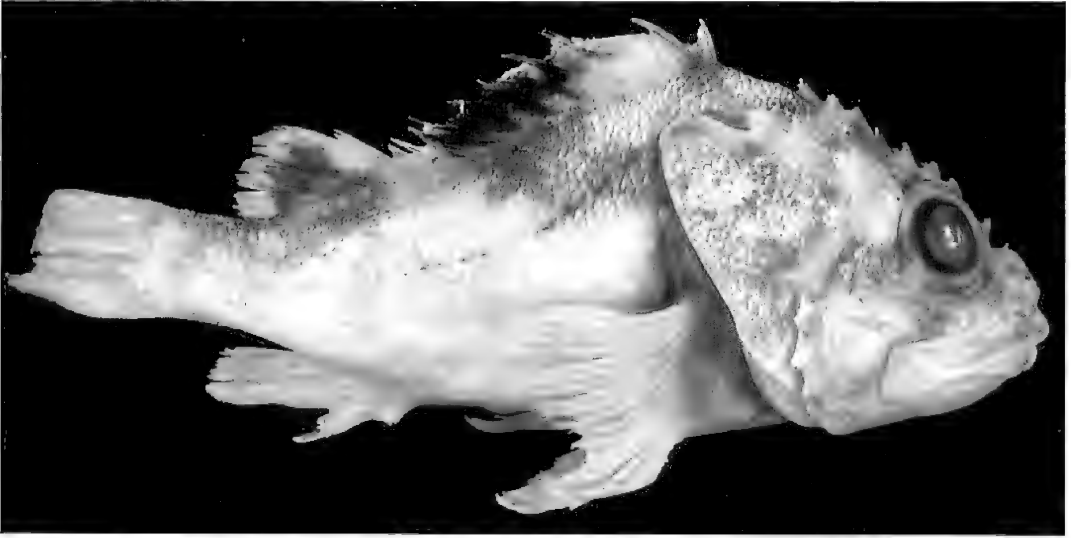


FIGURE 1. Holotype of *Trachyscorpia osheri* sp. nov., CAS 86509, 147 mm TL, right side (left pectoral fin is damaged), after extended preservation in ethanol.

nostril or on occiput, mid-interorbital space, snout, maxilla, lips, underside of lower jaw, preopercle, opercle, fins and lateral body surface. Pectoral-fin axil without skin flaps.

Exposed minute ctenoid scales covering occipital pit, opercle, and an area surrounded by tympanic, pterotic, parietal, nuchal and lower posttemporal spines. Interorbital space naked. Cycloid scales covering cheek and area surrounded by posterior margin of orbit, pterotic spine, preopercular margin and suborbital ridge (some scales weakly ctenoid). Other parts of head not covered with exposed or embedded scales. Well-exposed ctenoid scales on lateral surface of body, scales becoming cycloid beneath mid-chest continuing to ventral surface. Body scales extending onto basal rays and membranes of all fins except pelvic fins; scales on fins cycloid. Exposed cycloid scales covering pectoral-fin base and anteroventral surface of body; some scales embedded in thin skin. Lateral line sloping downward at tip of opercle.

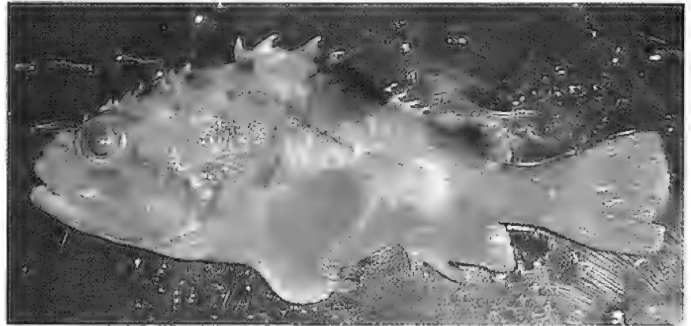


FIGURE 2. Holotype of *Trachyscorpia osheri* sp. nov., CAS 86509, 147 mm SL, photographed approximately four hours after capture and prior to preservation.

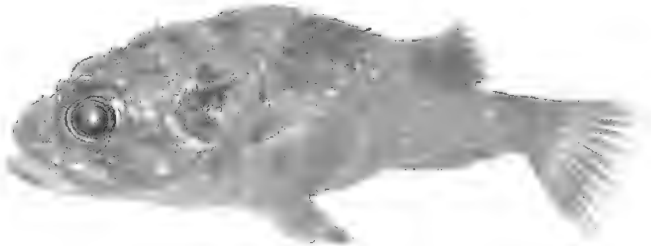


FIGURE 3. Paratype of *Trachyscorpia osheri* sp. nov., CAS 86504, 135 mm SL, photographed approximately four hours after capture and prior to preservation.

TABLE 1. Proportional Measurements of Type Specimens of *Trachyscorpia osheri* and *Idiastion hageyi* Expressed as Percentages of the Standard Length. *** = broken fin spine.

	<i>Trachyscorpia osheri</i>		<i>Idiastion hageyi</i>
	Holotype CAS 86509	Paratype CAS 86504	Holotype CAS 87916
Standard length (mm)	147	135	95
Total length (mm)	181	166	~116
Body depth	389	369	442
Body width	252	200	249
Head length	516	472	507
Snout length	126	106	125
Orbit diameter	144	150	136
Interorbital distance	71	71	68
Upper jaw length	254	242	249
Maxillary depth	77	74	74
Postorbital distance	267	273	272
Predorsal distance	481	512	475
Preanal distance	636	776	673
Prepelvic distance	438	424	402
1st dorsal spine	61	57	63
2nd dorsal spine	99	67	145
3rd dorsal spine	159	***	180
4th dorsal spine	***	109	178
5th dorsal spine	117	113	137
6th dorsal spine	117	116	39
11th dorsal spine	84	78	74
12th dorsal spine	129	133	121
Longest dorsal fin ray	180	164	162
1st anal spine	***	74	95
2nd anal spine	154	166	159
3rd anal spine	131	128	128
Longest anal fin ray	187	178	200
Pectoral fin ray length	229	224	358
Pelvic fin spine length	170	170	180
Longest pelvic fin ray	227	230	245
Caudal fin length	233	203	~221
Caudal peduncle length	201	208	153
Caudal peduncle depth	118	107	107

Sensory pores of cephalic lateralis system prominent; 3 large pores on cheek just below sub-orbital ridge, first just below posterior end of lacrimal, second below posterior margin of orbit, third below end of suborbital ridge. Underside of dentary with 3 sensory pores on each side, first below and anterior to tip of anterior lacrimal spine, second below tip of posterior lacrimal spine, third located posteriorly and slightly lower on dentary; a small pore behind symphyseal knob of lower jaw on each side; an indistinct pore on each side of symphyseal knob.

Mouth large, slightly oblique, gape forms an angle of about 25° to horizontal axis of head and body. Jaws subequal. Posterior margin of maxilla nearly reaching a vertical through posterior margin of orbit. Upper edge of posterior maxilla slightly swollen laterally; central part of maxilla flat. Lower jaw with a symphyseal knob. Width of symphyseal gap separating premaxillary teeth bands slightly greater than width of each band. Tooth band of upper jaw wider than that of lower jaw.

Upper jaw with a band of filiform teeth; tooth band narrowing posteriorly. Lower jaw with a band of villiform teeth; length of most teeth equal to those of upper jaw. Vomer with a single irregular row of small teeth, becoming larger laterally. Palatines covered with teeth. Underside of lower jaw smooth, without ridges.

Dorsal profile of snout steep, forming an angle of about 50° to horizontal axis of head and body. Nasal spine simple, small, embedded in skin; nasal spine tip directed posterodorsally, its length equal to posterior nostril diameter. Ascending process of premaxilla intrudes slightly into interorbital space, its posterior margin extending to level of posterior margin of posterior nostril and reaching level of middle of preopercular spine base in dorsal view. Median interorbital ridge absent. Interorbital ridges separated by a shallow channel, beginning posterior to nasal spines and joining at origin of tympanic spines; interorbital ridges unbranched, diverging anteriorly and posteriorly in dorsal view, distance between interorbital ridges narrowest at a vertical through anterior one-third of pupil. Interorbital space moderately shallow, about one-fourth of orbit extending above dorsal profile of head. Preopercular spine simple, directed posteriorly. Supraocular spine simple, its length equal to that of preocular and postocular spines and shorter than tympanic spine. Postocular spines simple, canted laterally. Tympanic spine simple, strongly pointed, directed dorsally. Interorbital, coronal and pretympanic spines absent. Occiput nearly flat, lacking pit; longitudinal length of occipital area greater than width; occiput surrounded laterally by tympanic spines, parietal spines and indistinct low ridges between tympanic and parietal spines. Parietal spine simple, equal to nuchal spine. Nuchal spine simple; nuchal and parietal spines joined at base. Pterotic spine simple, located below parietal and nuchal spines. No ridges in an area surrounded by parietal, nuchal, pterotic and lower posttemporal spines. Upper posttemporal spine absent. Lower posttemporal spine simple, its base less than that of pterotic spine. Supracleithral spine simple, pointed. Cleithral spine flattened, pointed. Lateral lacrimal spine simple, pointed. Anterior lacrimal spine not pointed, directed ventroposteriorly, its tip not reaching dorsal margin of upper lip; no additional spine occurring at base of anterior lacrimal spine. Posterior lacrimal spine simple, directed ventroposteriorly, its tip reaching upper lip; posterior lacrimal spine greater than anterior lacrimal spine. Suborbital ridge with 5 (6) spines, first and second spines below pupil, third spine below posterior margin of orbit, fourth and fifth spines between posterior margin of orbit and preopercular margin. Space between ventral margin of eye and suborbital ridge narrow. Suborbital pit absent. Preopercle with 5 spines; uppermost spine largest with a supplemental preopercular spine on its base; second to fifth spines without a distinct median ridge. Preopercle, between uppermost preopercular spine and upper end of preopercle, smooth without serrae or spines. Upper and lower opercular spines simple, minute, each with a shallow median ridge. Space between upper and lower opercular spines without ridges. Posterior tips of upper and lower opercular spines not reaching opercular margin.

Origin of first dorsal-fin spine above supraclithral spine. Posterior margin of opercular membrane extends to a vertical between third and fourth dorsal-fin spine bases. Posterior tip of pectoral fin reaching a vertical through origin of eleventh dorsal-fin spine and nearly reaches anal-fin origin. Origin of pelvic-fin spine in line with origin of pectoral fin. Posterior end of depressed pelvic fin extending slightly beyond anus and extending to a vertical through posterior tip of pectoral fin. Origin of first anal-fin spine slightly posterior to origin of last dorsal-fin spine.

Coloration of preserved specimens in ethanol: Head and body yellowish-white dorsally, whitish ventrally (Fig. 1). Two blackish broad bands on head; one running from middle of ventral margin of eye to fifth preopercular spine through dorsal angle of posterior margin of maxilla; the other running from posterior margin of eye to dorsal end of opercle. Poorly defined blotches on maxilla and lips. Anterior nostril tentacle dark distally. Inside of opercle black. Four blackish sad-

dles; first above opercle, including membranes between first and third dorsal-fin spines; second broadest, extending from basal half of membranes between fifth and twelfth dorsal-fin spines to below lateral line; third extending from basal membranes of dorsal-fin soft rays to above lateral line; fourth on posterior caudal-fin peduncle, reaching ventral surface of caudal-fin peduncle. Distal half of membranes between fourth and eleventh dorsal-fin spines black, forming an elongate black blotch. A poorly defined blackish blotch on middle of soft rayed portion of dorsal fin. Two poorly defined blackish blotches on base and middle of pectoral fin. Pelvic fin yellowish with poorly defined blackish blotches. Anal fin yellowish with a few melanophores. Caudal fin yellowish with a few scattered melanophores. Abdominal-cavity lining dusky.

Coloration soon after capture: Head and body reddish (Figs. 2–3), with blackish markings on posterior half of head, dorsal half of trunk, and fins, especially central pectoral fin.

Size: The type specimens are 135–147 mm (SL) and 166–181 mm in Total Length. Neither appear to be sexually mature. Maximum lengths (SL) of other species of *Trachyscorpia* are: *T. (M.) carmagula* 369 mm (Motomura et al. 2007); *T. (T.) cristulata cristulata* 50 cm (Robins and Ray 1986); *T. (T.) cristulata echinata* 50 cm (Eschmeyer and Dempster 1990); *T. (M.) eschmeyer* (as *T. capensis*) 35 cm (Eschmeyer 1986); and *T. (M.) longipedicula* 219 mm (Motomura et al. 2007).

DISTRIBUTION.— Known only from the type specimens, from the Galápagos Islands at depths between 402–515 m. The new species was observed from the submersible to inhabit boulder and sediment-laden bottoms, sitting on the bottom along 30°–45° slopes.

ETYMOLOGY.— I am pleased to name this lovely creature in honor of Bernard A. Osher, a keen fisherman, amateur ichthyologist, and supporter of research and education.

REMARKS.— *Trachyscorpia* contains two subgenera, *Trachyscorpia* (type species *T. cristulata*) and *Mesoscorpia* (type species *T. capensis*), and five species. The subgenus *Mesoscorpia* was described by Eschmeyer (1969) who differentiated it from *Trachyscorpia* by its having 13 dorsal spines (vs. 12 in the latter), 26 vertebrae (vs. 25), and a swimbladder (absent in *Trachyscorpia*). *Mesoscorpia* contains three species: *T. (M.) eschmeyer* Whitley 1970 (= *Scorpaena capensis* Gilchrist and von Bonde 1924, preoccupied) from the southeastern Atlantic and the southern Indo-West Pacific; *T. (M.) carmagula* Motomura et al. 2007 from Australasia; and *T. (M.) longipedicula* Motomura et al. 2007 from the southwestern Indian Ocean.

The new species is within the subgenus *Trachyscorpia* and is most closely related to the North Atlantic *Trachyscorpia (T.) cristulata*, the only other species within the subgenus. Two subspecies of *T. cristulata* are currently recognized, *T. c. cristulata* Goode and Bean 1896 and *T. c. echinata* Koehler 1896, however Motomura et al. (2007:33) suggest that the subspecies of *cristulata* are perhaps distinct species and a direct comparison of specimens must be made. *Trachyscorpia osheri* differs from *T. cristulata* in several characters that are readily apparent: the dorsal profile of the body of *T. osheri* is arched (vs. nearly straight in *T. cristulata*); the nasal spines of *T. osheri* are minute (vs. elongate); and the occipital pit, maxillary, and internasal band are naked (vs. scaled). As well, the pectoral fin of *T. osheri* is deeply notched, such that the 11th ray is 65% of the 17th; the pectoral fin of *T. cristulata* is barely notched, the 11th ray being 90% of the 17th.

COMPARATIVE MATERIAL EXAMINED.— *Trachyscorpia cristulata*: CAS 31783, 155 mm SL, Atlantic Ocean (28°50'N, 79°54'W), 393 m; CAS 32472, 205 mm SL, Florida, off Atlantic coast (29°58'N 80°08'W), 379 m.

FAMILY SCORPAENIDAE

Idiastion hageyi McCosker, sp. nov.

Galapagos humpback scorpionfish

Figures 4–5.

MATERIAL EXAMINED.— HOLOTYPE: CAS 87916, 95 mm SL, female with developing ova, Islas Galápagos, Isla Fernandina, Cabo Douglas, 00°17.53'S, 91°38.35'W, suction-captured from the submersible *Johnson Sea-Link* (JSL Dive 3957) at 522 m by J.E. McCosker and party on 16 Nov. 1995.

DIAGNOSIS.— A species of *Idiastion* with the following characteristics: dorsal-fin rays XII-9; anal-fin rays III-6; pectoral fin rays 18; vertebrae 25; 52 scale rows in longitudinal series; 15–16 pored lateral-line scales; body deep (depth 44% SL), humpbacked; orbit diameter large (15% SL); head spines strong, well developed; swimbladder present; coloration reddish-orange, with irregular white blotches on head, body, and pectoral fin bases.

DESCRIPTION OF THE HOLOTYPE.— Proportional measurements are given as percentages of SL in Table 1. Dorsal fin with 12 spines and 9 soft rays; all soft rays branched; length of first spine 2.3 in second spine, 2.8 in third spine; seventh to tenth spines progressively shorter; length of twelfth spine 1.6 that of eleventh; membrane of spinous portion of dorsal fin deeply notched between spines 1–4, moderately notched between spines 4–12; posterior branch of last dorsal soft ray joined by membrane to caudal-fin peduncle for less than one-fourth of its length. Anal fin with 3 spines and 6 soft rays; all soft rays branched; second and third spines much longer than first; first through third soft rays the longest, their length slightly longer than that of second anal-fin spine; posterior branch of last soft ray joined by membrane to caudal-fin peduncle for less than one-seventh of its length. Pectoral fins with 18 rays on each side, the uppermost and lowest 3 rays unbranched, remaining rays branched; ninth to thirteenth rays longest; rays in lower lobe thickened, fleshy. Pelvic fin with 1 spine and 5 (5 left, 4 right) soft rays, all soft rays branched; base of first to fifth rays covered with fleshy skin; second soft ray longest, its length slightly less than upper-jaw length. Caudal fin with 16 segmented rays and 12 branched rays, the upper 2 and lower 3 rays unbranched; dorsal procurent rays 5, ventral rays 4; posterior margin of fin appears straight (damaged during capture). Caudal-peduncle depth 1.4 in caudal-peduncle length.

Scale rows in longitudinal series ~52. Pored lateral-line scales 16 (15 right); posteriormost scale beneath eighth (ninth, right) dorsal ray. (All lateral-line scales appear to be present and undamaged.) Scales below lateral line 13. Scale rows between base of sixth dorsal-fin spine and lateral line 7. Predorsal scale rows ~12. Gill rakers 8 on upper limb, 12 on lower limb. Gill rakers relatively short and slightly spinous with numerous minute serrae, longest raker on first gill arch 1.4 times that of longest gill filaments around angle of gill arch; a small slit behind the fourth arch. 12 pseudobranchial filaments. Swimbladder small. Branchiostegal rays 6 (covered with thick membrane and difficult to ascertain). Vertebrae 25.

Body compressed posteriorly. Nape steep, anterior body not strongly arched. Body relatively deep, hump-backed in appearance, its depth about equal to head length. No distinct small papillae on head; a distinct row of papillae nearly surrounds outer edge of pupil. Slender tentacles absent from dorsal margin of eye membrane. No distinct tentacles on posterior ends of preocular, supraocular and postocular spine bases. A slender tentacle on posterodorsal edge of low membranous tube associated with anterior nostril; length of tentacle slightly longer than anterior nostril height. A simple slender tentacle at end of each preopercular, supraocular, posterior lacrimal, and paired nuchal spines. No tentacles associated with posterior nostril or on occiput, mid-interorbital space, snout, maxilla, lips, underside of lower jaw, preopercle, opercle, fins and lateral body surface. Pectoral-fin axil without skin flaps.

Exposed minute ctenoid scales covering occipital pit and an area surrounded by tympanic,

pterotic, parietal, nuchal and lower posttemporal spines, extending to base of first dorsal spine. Interorbital space scaleless, but with minute papillae. Cycloid scales overlay opercle, less abundant along ventral edge. Other parts of head not covered with exposed or embedded scales. Ctenoid scales on lateral surface of body, becoming cycloid beneath mid-chest, continuing to ventral surface. Body scales extending onto basal rays; membranes of all fins scaleless. Exposed cycloid scales covering pectoral-fin base; anteroventral surface of body scaleless. Lateral line sloping slightly downward at tip of opercle.

Sensory pores of cephalic lateralis system prominent; 3 pores on cheek just below suborbital ridge, first minute and just below posterior lacrimal spine, second large and below anterior margin of pupil, third large and below middle of suborbital ridge. Underside of dentary with 3 sensory pores on each side, first below tip of anterior lacrimal spine, second reduced and below tip of posterior lacrimal spine, third located posteriorly and slightly lower on posterior edge of dentary; a small pore on each side behind symphyseal knob of lower jaw.

Mouth large, slightly oblique, gape forming an angle of about 15° to horizontal axis of head and body. Lower jaw slightly protruding. Posterior margin of maxilla nearly reaching a vertical through posterior margin of orbit. Upper edge of posterior maxilla slightly swollen laterally; central portion of maxilla flat. Lower jaw with a symphyseal knob. Width of symphyseal gap separating premaxillary teeth bands slightly greater than width of each band. Tooth band of upper jaw wider than that of lower jaw. Upper jaw with a band of filiform teeth; tooth band narrowing posteriorly. Lower jaw with a band of villiform teeth; length of most teeth subequal to those of upper jaw. Vomer with an irregular row of small teeth. Palatines covered with a patch of small teeth. Underside of lower jaw smooth, without ridges.

Dorsal profile of snout moderately steep, forming an angle of about 50° to horizontal axis of head and body. Head spines strong, developed. Nasal spine simple, small, embedded in skin, except for spine tip, directed dorsally, its length less than posterior nostril diameter. Ascending process of premaxilla lies slightly below interorbital space. Median interorbital ridge absent. Interorbital ridges separated by a shallow channel, beginning at posterior margin of posterior nostril and joining at origin of tympanic spines; interorbital ridges unbranched, diverging anteriorly and posteriorly in dorsal view; distance between interorbital ridges narrowest at a vertical through anterior margin of pupil. Interorbital space moderately shallow, about one-fourth of orbit extending above dorsal profile of head. Preopercular spine simple, directed posteriorly. Supraocular spine simple, its length greater than preocular and less than tympanic spines. Postocular spines simple, canted laterally. Tympanic spine simple, strongly pointed, canted laterodorsally. Interorbital, coronal and pretympanic spines absent. Occiput nearly flat, lacking a deep pit; longitudinal length of occipital area greater than width; occiput surrounded laterally and posteriorly by tympanic spines, parietal spines, and indistinct low ridges between tympanic and parietal spines. Parietal spine simple, equal to nuchal spine. Nuchal spine simple; nuchal and parietal spines joined at base. Pterotic spine simple, located below parietal and nuchal spines. No ridges in an area surrounded by parietal, nuchal, pterotic and lower posttemporal spines. Upper posttemporal spine absent. Lower posttemporal spine simple, its base less than that of pterotic spine. Supracleithral spine small, simple, pointed. Cleithral spine larger, pointed. Lateral lacrimal spine simple, pointed. Anterior lacrimal spine not pointed, directed ventroposteriorly, its tip not reaching dorsal margin of upper lip; no additional spine occurring at base of anterior lacrimal spine. Posterior lacrimal spine simple, directed ventrally, its tip not reaching upper lip; posterior lacrimal spine and anterior spine subequal. Suborbital ridge with 5 spines, the third bicuspid; first, second and third spines below pupil, fourth spine below posterior margin of orbit, fifth and sixth spines between posterior margin of orbit and preopercular margin. Space between ventral margin of eye and suborbital ridge narrow. Suborbital pit

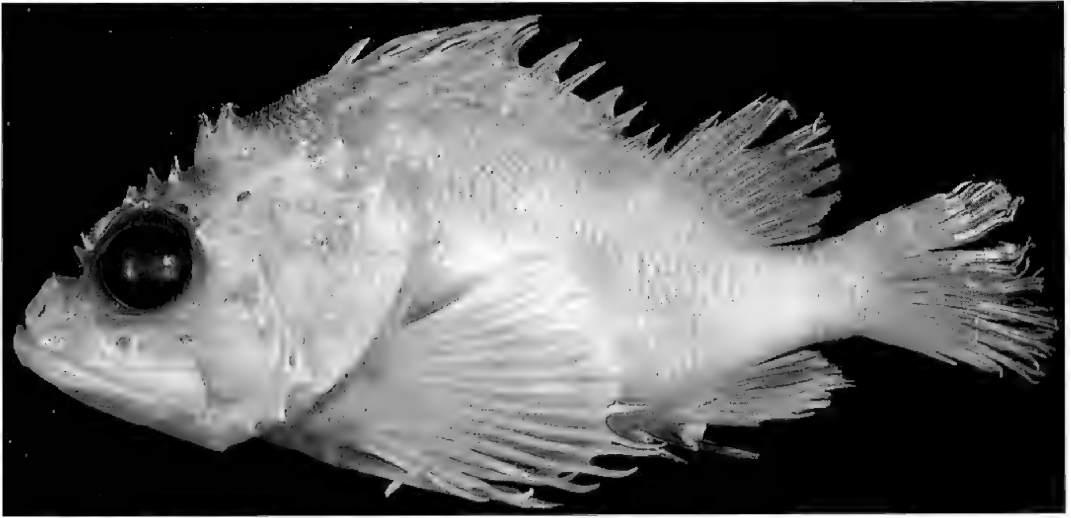


FIGURE 4. Holotype of *Idiastrion hageyi* sp. nov., CAS 87916, 95 mm SL, female, after extended preservation in ethanol.

absent. Preopercle with 4 spines; uppermost spine largest with a supplemental preopercular spine on its base; second to fourth spines flattened, without a distinct median ridge. Preopercle, between uppermost preopercular spine and upper end of preopercle, smooth, without serrae or spines. Upper and lower opercular spines simple, minute, each with a shallow median ridge. Space between upper and lower opercular spines without ridges. Posterior tip of upper opercular spine not reaching opercular margin; posterior tip of lower opercular spine just reaches opercular margin.



FIGURE 5. *Idiastrion hageyi* photographed at Isla Fernandina, Cabo Douglas, at 522 m, 16 November 1995.

Origin of first dorsal-fin spine above supracleithral spine. Posterior margin of opercular membrane extends to a vertical between third and fourth dorsal-fin spine bases. Posterior tip of pectoral fin reaching a vertical through origin of fourth dorsal-fin ray and nearly reaches base of first anal-fin ray. Origin of pelvic-fin spine in line with origin of pectoral fin. Posterior end of depressed pelvic fin extending slightly beyond anus and falls short of a vertical through posterior tip of pectoral fin. Origin of first anal-fin spine in line with origin of first dorsal-fin ray.

Coloration of preserved specimen in ethanol: Specimen (Fig. 4) entirely pale. Fine specks of dark pigment exist at the pectoral base and beneath many body scales.

Coloration when alive: (Based on photograph, Fig. 5.) Head, body, and fins uniformly reddish-orange, overlain on head, body, and pectoral-fin bases with distinct irregular white blotches all smaller than orbit. Skin along all dorsal spines white; membrane of dorsal spines 1–3 white, membrane of dorsal spines 4–12 colored like body. Posterior margin of caudal, pectoral, soft-dorsal and anal fins white-edged. Faint blackish smudges along opercle, around orbit, along base of dorsal fin, and on nape and interorbital region. Abdominal cavity lining with a few fine dark speckles.

Size: Known only from the type specimen, 95 mm SL (~116 mm TL). Maximum lengths (SL) of other species of *Idiastion* are: *I. kyphos* 105.4 mm (Anderson et al. 1975) and *I. pacificum* 128.4 mm (Ishida and Amaoka 1992).

DISTRIBUTION.— Known only from the holotype, collected off Isla Fernandina, Galápagos Islands, at a depth of 522 m. The new species was observed from the submersible to occupy steep boulder and sediment-laden bottoms, sitting on the bottom along a 60° slope.

ETYMOLOGY.— I am pleased to name this interesting scorpionfish in honor of Harry R. Hagey, an avid fisherman, naturalist, trustee and supporter of the California Academy of Sciences.

REMARKS.— *Idiastion* is now known from three species, including *I. kyphos* Eschmeyer 1965, trawled at 585–622 m from the southeastern Caribbean, and *I. pacificum* Ishida and Amaoka 1992, from 355–375 m along the Kyushu-Palau Ridge of the western Pacific Ocean.

Eschmeyer (1969) and Anderson et al. (1975) reported upon six subsequent specimens of *I. kyphos* from off Venezuela, off northeastern Florida, and off Angola, between depths of 229–622 m. On the basis of the original and those subsequent descriptions of *I. kyphos*, I am able to differentiate it from the new species which has fewer pored lateral-line scales (15–16 vs. 23–24), six vs. five anal-soft rays, a deeper body (42% of SL vs. 36–39%), and a slightly smaller orbit (horizontal diameter 12.9% of SL vs. 14–16%). The new species appears to have six branchiostegal rays (*I. kyphos* has 7), however the fleshy tissue overlaying those rays makes their counts uncertain. Nothing is known of the coloration of *I. kyphos* prior to preservation (Eschmeyer 1965; Anderson et al. 1975), however specimens in preservative possess faint bars of brown pigment on the head and body; such pigmentation was absent in *I. hageyi* whether alive or in preservative.

The new species differs from *I. pacificum* in having fewer pored lateral-line scales (15–16 vs. ~26), six vs. five anal-soft rays, a deeper body (42.0% of SL vs. 38.6%), and a slightly smaller orbit (12.9% of SL vs. 15.8%). The longest dorsal spine of *I. hageyi* is the third, whereas the fourth dorsal spine of *I. pacificum* is considerably longer than the third. Ishida and Amaoka (1992: 359) described the coloration in alcohol of *I. pacificum* to be “uniformly pale, without any markings,” but suggested that the 63 mm SL specimen collected concurrently with their type specimen and identified as “Scorpaeninae sp.” by Kanayama (1982) might be conspecific. The color photograph of Kanayama’s specimen (orange with a few large pale areas) looks nothing like *I. hageyi* in its coloration, however it appears similar to *I. pacificum* in its morphometry.

COMPARATIVE MATERIAL EXAMINED.— *Idiastion kyphos* CAS 24401, 99 mm SL, Angola (17°18’S, 11°24’E), 229–274 m; CAS 31886, 85 mm SL, Caribbean Sea, (12°11’N 72°52’W), 550 m.

ACKNOWLEDGMENTS

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LITERATURE CITED

- ANDERSON, W.D., Jr., J.F. MCKINNEY, AND W.A. ROUMILLAT. 1975. Review of the scorpaenid genus *Idiastion*. *Copeia* 1975(4):780–782.
- ESCHMEYER, W.N. 1965. Three new scorpionfishes of the genera *Pontinus*, *Phenacoscorpius*, and *Idiastion* from the western Atlantic Ocean. *Bulletin of Marine Science* 15(3):521–534.
- ESCHMEYER, W.N. 1969. A systematic review of the scorpionfishes of the Atlantic Ocean (Pisces: Scorpaenidae). *Occasional Papers of the California Academy of Sciences* no. 179. 143 pp.
- ESCHMEYER, W.N. 1986. Family No. 149 Scorpaenidae. Pages 463–478 in M. Smith and P. Heemstra, eds., *Smith's Sea Fishes*. Macmillan Publishing Company, Johannesburg, South Africa.
- ESCHMEYER, W.N. AND L.J. DEMPSTER. 1990. Scorpaenidae. Pages 665–679 in J.C. Quéro et al., eds., *Checklist of the Fishes of the Eastern Tropical Atlantic*, vol. II. UNESCO, Paris, France.
- GILCHRIST, J.D.F. AND C. VON BONDE. 1924. Deep-sea fishes procured by the S.S. "Pickle" (Part II). *Report/Fisheries and Marine Biological Survey, Union of South Africa* 3:1–24.
- GOODE, G.B. AND T.H. BEAN. 1896. Oceanic ichthyology, a treatise on the deep-sea and pelagic fishes of the world, based chiefly upon the collections made by the steamers Blake, Albatross, and Fish Hawk in the northwestern Atlantic. *Bulletin of the United States National Museum* no. 2. 553 pp.
- ISHIDA, M. AND K. AMAOKA. 1992. A new species of the fish genus *Idiastion* (Pisces: Scorpaenidae) from the Kyushu-Palau Ridge, western Pacific. *Japanese Journal of Ichthyology* 38(4):357–360.
- KANAYAMA, T. 1982. Scorpaenidae. Pages 270–279, 392–397 in O. Okamura et al., eds. *Fishes of the Kyushu-Palau Ridge and Tosa Bay*. Japan Fisheries Resource Conservation Association, Tokyo, Japan. 435 pp.
- KOEHLER, R. 1896. Résultats scientifiques de la campagne du "Caudan" dans le golfe de Gascogne — Août-Septembre 1895 — Poissons. *Annales de l'Université de Lyon* 26:475–526.
- LEVITON, A.E., R.H. GIBBS, JR., E. HEAL, AND C.E. DAWSON. 1985. Standards in herpetology and ichthyology: part I. Standard symbolic codes for institutional resources collections in herpetology and ichthyology. *Copeia* 1985(3):802–832.
- MCCOSKER, J.E. 1997. A letter from the field: A half mile down. *Pacific Discovery* 50(1):42–45.
- MOTOMURA, H. 2004. A new species of scorpionfish, *Scorpaena cocosensis* (Scorpaeniformes: Scorpaenidae) from the Cocos Islands, Costa Rica, Eastern Pacific Ocean. *Copeia* 2004(4):818–824.
- MOTOMURA, H., P.R. LAST, AND G.K. YEARSLEY. 2007. Two new species of the scorpionfish genus *Trachyscorpia* (Sebastidae: Sebastolobinae) from the southern Indo-West Pacific, with comments on the distribution of *T. eschmeyeri*. *Zootaxa* (1466):19–34.
- RANDALL, J.E. AND W.N. ESCHMEYER. 2001. Revision of the Indo-Pacific scorpionfish genus *Scorpaenopsis*, with descriptions of eight new species. *Indo-Pacific Fishes* no. 34. 79 pp.
- ROBINS, C.R. AND G.C. RAY. 1986. *A Field Guide to Atlantic Coast Fishes of North America*. The Peterson Field Guide Series, Boston, Massachusetts, USA. 354 pp.
- WHITLEY, G.P. 1970. Ichthyological quiddities. *Australian Zoologist* 15:242–247.

First Atlantic Record of *Asthenomacrus victoris* Sazonov & Shcherbachev (Macrouridae, Gadiformes, Teleostei)

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The rare abyssal benthic fish *Asthenomacrus victoris* Sazonov and Shcherbachev, 1982 was previously known from only three type specimens captured on oceanic ridges of the Indian Ocean, one from off Japan, and two others from southeastern Australia. It is here reported for the first time in the North Atlantic from one specimen taken on the Mid-Atlantic Ridge at a depth of 3036 m during the 2004 MAR-ECO Expedition. Additional specimens from southeastern Australia are also recorded, and the species is compared with its only congener, *A. fragilis* (Garman, 1899).

During the 2004 MAR-ECO Expedition of the R/V *G. O. Sars*, a series of deep bottom-trawl stations were made on the Mid-Atlantic Ridge north of the Azores (Bergstad et al. 2008). At one station at a depth of 3036 m, a single somewhat-damaged specimen of what was initially identified onboard ship as *Sphagemacrus hirundo* (Collett, 1897) was captured. On examination of the specimen during the MAR-ECO Fish Taxonomy Workshop held at the Espegrend Marine Biological Station of the University of Bergen in February 2005, we erroneously determined that it represented an undescribed species of the genus *Kumba* Marshall, 1973, and it was reported as such by Bergstad et al. (in press). However, subsequent closer examination of the damaged vent area revealed that the anus was situated close before the anal fin and there was no sign of a ventral light organ—two features that precluded *Kumba* and suggested instead either *Asthenomacrus* Sazonov and Shcherbachev, 1982 or *Macrosomia* Merrett, Sazonov, and Shcherbachev, 1983. The latter genus was eliminated because of the absence in the MAR-ECO specimen of a greatly enlarged olfactory organ. Despite its damaged condition, most of the important diagnostic features remained intact to determine that it belonged to *A. victoris* Sazonov and Shcherbachev, 1982, a species known previously from only five specimens, two from the Indian Ocean, one from off Japan, and two from off southeastern Australia (Iwamoto and Graham 2001). Additional specimens of the species were examined by the first author during visits to Australian museums in 2003. It is the purpose of this paper to record these additional specimens and compare the species more closely with its only congener, *A. fragilis* (Garman, 1899) from the eastern central Pacific.

MATERIALS AND METHODS

Representatives of the genus were examined at AMS, CAS, CSIRO, MCZ, NMV, SIO, UMML, WAM, ZISP, ZMMGU, and ZMUB. The reader is referred to Eschmeyer (1998) for complete references for taxon names here cited as well as institutional abbreviations, which are more current than those of Leviton et al. (1985) and Leviton and Gibbs (1988). Methods for making

counts and measurements follow procedures outlined in Iwamoto and Sazonov (1988). Because of the fragile and weak head bones of these fishes, most specimens examined were damaged and in poor condition, making accurate measurements difficult and sometimes impossible. This was of particular concern with measurement of the snout length, a crucial component of the head length, which we use as the standard of comparison of other body and head parts. Since most of the Australian specimens were examined during hurried visits focused on a wide array of grenadier species, adequate time was usually not available to allow reconstruction of parts to get more accurate measurements. We feel, however, that enough measurements were taken to provide good characterization of the species. Counts and measurements of *A. fragilis* were taken during an earlier study (Iwamoto, 1979), in which seven specimens (including four type specimens) were examined. Collection information for those specimens is provided in that work.

Genus *Asthenomacrus* Sazonov and Shcherbachev, 1982

Asthenomacrus Sazonov and Shcherbachev, 1982: 2 (type species *Asthenomacrus victoris* Sazonov and Shcherbachev, 1982, by original designation.)

DIAGNOSIS.— Branchiostegal rays 7. Anus and associated periproct region abutting anal fin origin. No apparent dermal window of light organ. Pelvic fin with 7–9 rays, fin origin under preopercle, far in advance of vertical through pectoral fin base; leading edge of spinous second ray of first dorsal fin weakly and sparsely serrated; pectoral fins placed relatively high on body, upper margin about on or near level with dorsal margin of opercle. Head bones weak and flexible; snout relatively high, its tip about on same horizontal as center of orbit; mouth large; upper jaw extending beyond vertical through posterior margin of orbit. Almost all of underside of head naked, including snout ventrally and along upper anterior margin. Scales small, usually covered with short, erect spinules in 1–3 parallel to slightly divergent crestlike rows. Pyloric caeca short, thick, 7–10.

REMARKS.— Sazonov and Shcherbachev (1982) described *Asthenomacrus* to include their new species *A. victoris* from the central and eastern Indian Ocean and off Japan. They also included in their new genus *Macrurus fragilis* Garman, 1899, a poorly known species from the eastern tropical Pacific that, after its initial description in the catch-all genus *Macrurus*, was placed by Gilbert and Hubbs (1916) in their concept of *Lionurus* Günther, and later removed by Iwamoto (1979) to *Paracetonurus* Marshall, 1973. Sazonov and Shcherbachev (1982) and Merrett et al. (1983) discussed in depth the generic problems associated with these taxa. They considered *Asthenomacrus* to be closest related to the monotypic *Macrosmia* Merrett, Sazonov and Shcherbachev, and less so to *Paracetonurus* and *Pseudonezumia* Okamura, 1970. The MAR-ECO specimen represents the first record of the genus from the Atlantic.

Asthenomacrus victoris Sazonov and Shcherbachev, 1982

Figures 1–3

Asthenomacrus victoris Sazonov and Shcherbachev, 1982:3–5 (Holotype and 2 paratypes; Indian Ocean and off Japan. Iwamoto and Graham, 2001:435 (2 specimens from off New South Wales, Australia, in 1642–1896 m).

DIAGNOSIS.— A species of *Asthenomacrus* with head laterally compressed, much deeper than wide, interorbital space about (28)35–39% of HL. Snout high, preoral (or ventral) length 29–40% HL, acutely pointed in lateral profile, length about equal to or shorter than interorbital width. Chin barbel very slender, its length 11–17% HL, about equal to pupil diameter, slightly less

than least depth of suborbital region. Head pores not prominent. Pyloric caeca short, thick, 8–10 total. Pelvic finrays 7 or 8.

SPECIMENS EXAMINED.—ZMMGU P15349 (holotype: 37 mm HL, 249+ mm TL); Mid-Indian Ridge; 02°46'S, 65°41'E; 3530 m. ZMMGU P16012 (paratype: 42.5 HL, 225+ TL); Naturaliste Plateau, se. Indian Ocean; 33°42'S, 110°53'E, 2320–2350 m. ZIN 45000 (paratype: 39 HL, 223+ TL); off Honshu, Japan; 36°45'N, 142°46'E; 3460 m. ZMUB 6267 (38.1 HL, 230+ TL); Mid-Atlantic Ridge, 42°46'N, 29°16'W, 3036 m; RV *G. O. Sars*, Super St. 46, Local St. 372. NMV A7000 (42.8 HL, 215+ TL) and NMV A7001 (ca. 25.7 mm HL, 154 TL); off New South Wales, Australia; 34°42'S, 151°22'E; 1896–1642 m. CSIRO H5304–13 (42.9 HL, 200+ TL) and CSIRO H5304–38 (3 spec., 37–43 HL, 172+–190+ TL); off Victoria, Australia; 38°34'S, 149°28'E; 1979–1954 m. CSIRO H5313–05 (47 HL, 225+ TL); Tasmania, Australia; 39°48'S, 149°06'E; 1973–1946 m. AMS I.32446–001 (40 HL, 218+ TL); off Queensland, Australia; 11°35'49"S, 145°29'08"E; 1789–1876 m.

COUNTS (see also Table 1).—ID II,8 or 9; P i17–i21; V 7 or 8; gill-rakers total on first arch (outer/inner) 8–11 / 13–14, on second arch 11–14 / 11–13; scale rows below origin of second dorsal fin about 7.5.

MEASUREMENTS (in percent of head length based on specimens examined and original description; see also Table 1).—Snout length 29–40%; preoral length 29–37%; internasal width 25–33%; interorbital width 28–39%; orbit diameter 22–30%; suborbital depth 15–21%; postorbital length 43–50%; distance orbit to angle of preopercle 41–49%; upper jaw length 36–42%; length barbel 11–17%; length outer gill slit 14–19%; preanal length 126–147%; greatest body depth 71–93%; height first dorsal fin 44–65% (2 spec.); length pectoral fin 47–72%; length outer pelvic ray 66–82%; interspace between first and second dorsal fins 21–37%.

TABLE 1. Comparison of selected measurements and counts of *Asthenomacrus victoris*, *A. fragilis*, and MAR-ECO specimen ZMUB 6267.

	<i>Asthenomacrus victoris</i>			<i>A. fragilis</i>
	MAR-ECO spec.	current specimens	types (original descr)	
Measurements				
Total length (mm)	230	146+–225+	223+–249+	175+–200
Head length (mm)	28.1	25.7–47.0	37–42.5	26–35
		(in percent of head length)		
Snout length	29	31–40	30–32	26–35
Preoral length	29	29–36	29–37	—
Orbit diameter	26	22–27	22–30	22–23
Interorbital width	28	35–39	35–39	24–27
Postorbital length	49	43–50	45–47	—
Orbit to preopercle	42	41–49	42–44	33–44
Suborbital depth	18	16–21	15–18	—
Upper jaw length	39	36–42	38–41	31–39
Barbel length	15	11–15	13–17	19–24
Outer gill-slit length	19	14–19	18–19	17–20
Preanal length	136	126–147	139–141	—
Length V	72	66–82	69–71	—
1D–2D interspace	24	21–23	23–37	—
Body depth	79	73–93	71–77	66–69
Counts				
ID	II,9	II,8–9	II,8–9	II,6–9
P (incl. rudim. ray)	18–19	17–21	21–22	19–21
V	7–8	7–8	7–8	8–9
Gillrakers I (outer)	8	8–11	8–9	—
Gillrakers I (inner)	13	13–14	13–14	10–11
Gillrakers II (outer)	13	11–14	12–13	—
Gillrakers II (inner)	13	11–13	11–13	9–11
Pyloric caeca	9	—	8–10	10–15

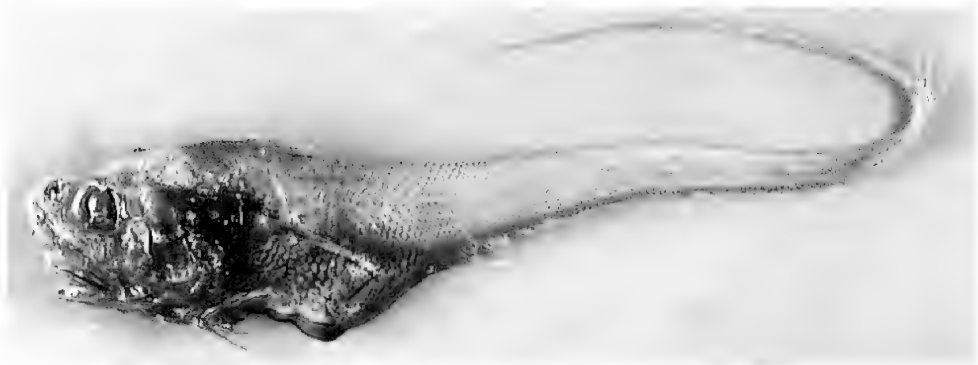
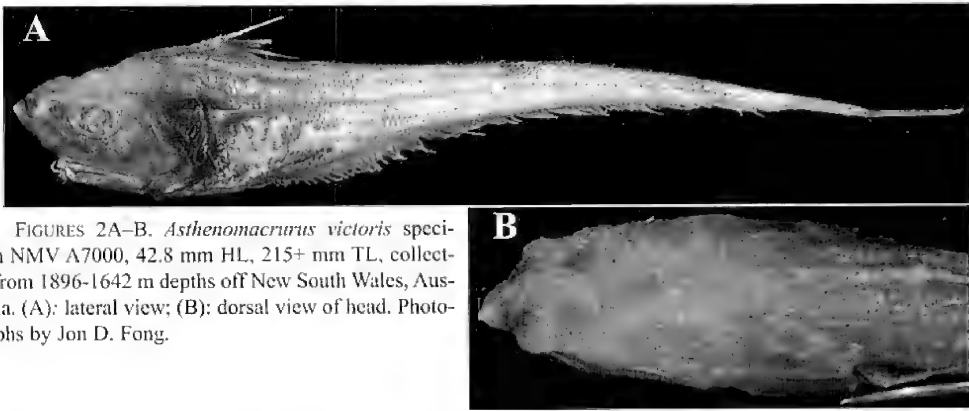


FIGURE 1. *Asthenomacrus victoris*, ZMUB 6267, 36.2 mm HL, 230+ mm TL, from 3036 m depth on Mid-Atlantic Ridge north of Azores. Photograph by Ingvar Byrkjedal.



FIGURES 2A–B. *Asthenomacrus victoris* specimen NMV A7000, 42.8 mm HL, 215+ mm TL, collected from 1896–1642 m depths off New South Wales, Australia. (A): lateral view; (B): dorsal view of head. Photographs by Jon D. Fong.

DESCRIPTION OF MAR-ECO SPECIMEN (Fig. 1; comments on other specimens enclosed within in parentheses).— Trunk relatively deep, tapering into a long slender tail; head length 6.0 (5–6 or more times) in total length. Head deep, compressed, its width about 1.5 into depth at hind margin of orbit; head bones relatively soft, pliable, weakly ossified; mucous chambers not greatly expanded. Snout pointed in lateral view, although median nasal rostrum very weak and easily bent to side, to give appearance of a blunt snout. Orbit round in outline, diameter less than width of broad interorbital or snout length. Suborbital region relatively flat and vertical (but possibly more rounded in life), dorsally scaly, naked ventrally below suborbital ridge, with some overlap of scales onto ventral surfaces. Preopercle large, broadly rounded posteroventrally, its posterior margin slightly (moderately) inclined from vertical, its ridge strongly developed. Interopercle narrowly exposed beyond preopercle margin along posterior and ventral margins. Opercle rather small, covering part of deep, slender subopercle. Mouth wide, upper jaws extend somewhat behind posterior margin of orbits; lips rather papillaceous. Chin barbel slender, tapering into a hairfine distal tip. Gill membranes narrowly connected across isthmus; gill openings wide, extending from upper margin of pectoral-fin base to under posterior margin of orbit.

First dorsal fin relatively small, fin rays weak and distal portions easily broken off; second spinous ray well developed and weakly serrated along leading edge (depressed ray extends posteriorly in one CSIRO specimen to about 10th dorsal ray). Second dorsal fin begins close behind first dorsal; its rays low and rudimentary over almost entire length. Anal fin relatively well developed to end of tail, its origin about below interspace of dorsal fins. Pectoral fin high, positioned above

mid-lateral line, the upper margin of fin base close to level of upper margin of opercle; the base well anterior to origin of first dorsal fin. Pelvic fins small, positioned far forward, anterior to pectoral fin, with its origin below posterior margin of orbit; outer ray relatively thick, tapering into a long thin filament (that extends to 5th to 16th anal ray).

Anus and urogenital pore within a small naked black periproct region immediately anterior to anal fin. (In specimens where abdominal wall broken or slit, the intestines relatively short, usually with only two or three folds.) Well-developed ovaries contained large oocytes, about 0.6–1.0 mm in diameter (including holotype and one other specimen).

Scales almost entirely missing on body (of most specimens); scattered few remaining on chest behind isthmus small with characteristic short, conical, erect spinules in 1–3 rows. Scales on head small, with one or few crest-like rows of short, conical spinules; most of ventral surfaces of head naked except for one small scale at posterior end of each mandibular ramus (also in one other specimen). A broad swath of small scales, each with a single row of short conical spinules below nasal fossa, the scaly swath continuing on dorsal surface of suborbital, with some overlapping ridge to underside; no modified, thickened scales on suborbital ridge and shelf. Broad ventral margins of preopercle and interopercle naked, but most of preopercle, opercle, and subopercle apparently scaly, based on presence of weakly defined scale pockets. One or two rows of cycloid scales on cleithrum beneath gill cover.

Jaw teeth all small, sharp, conical, in long tapered bands in premaxillary, three or four teeth wide at symphysis narrowing to two irregular rows posteriorly; dentary teeth in narrow band, about three rows wide anteriorly, tapering to one row posteriorly.

Color of fresh MAR-ECO specimen (from photograph; Fig. 1): ground color of tail and dorsal aspects of trunk dark brown. Abdomen black, with underlying skin violet (scale pockets prominently outlined in black); denuded surfaces of operculum, jaws, branchiostegal and gill membranes black; head dorsally grayish in denuded areas, medium brown over scaled area; first dorsal, pectoral, and pelvic fins black proximally, paler, somewhat brownish distally; anal fin blackish anteriorly becoming brownish to pale posteriorly over most of length. Color in alcohol (Figs. 2a–b) brownish to swarthy over most of dorsal aspects of trunk, becoming paler on tail; abdominal region blackish, with underlying bluish integument. Most of head blackish, including anterodorsal margin of snout, but colorless or whitish posterior to that margin on dorsal surface of snout posteriorly onto interorbital and nape. Lips, gill membranes, and inner lining of gill cavity blackish; mouth, gums, gill arches dark gray, barbel a lighter gray; gill filaments pale.

COMPARISONS.—Measurements and counts of the MAR-ECO specimen are compared with those of specimens from the Indian Ocean and western Pacific and with *A. fragilis* (Table 1). The specimen agrees well in almost all characters with *A. victoris*. The only notable difference found was the decidedly narrower interorbital (28% vs. 35–39% HL). Despite the somewhat damaged condition of the MAR-ECO specimen, the interorbital space appeared relatively normal and intact, giving no reason to doubt the measurement made (or its identification as *A. victoris*).

Compared with *A. fragilis*, *A. victoris* has a somewhat larger orbit (22–30% vs. 22–23%), slightly broader interorbital ([28]35–39% vs. 24–27%), shorter barbel (11–17% vs. 19–24%), fewer average numbers of pectoral fin rays (16–20 vs. 19–21), more inner gill rakers (13–14 vs. 10–11 on first arch, 11–13 vs. 9–11 on second arch), and possibly fewer pyloric caeca (8–10 vs. 10–15).

REMARKS.—The presence of *A. victoris* in the North Atlantic came as somewhat of a surprise, considering how relatively extensively the region has been explored over the past century. However, if we consider the small number of successful bottom trawls made at 3000 m and deeper and that sampling at such depths on the Mid-Atlantic Ridge has been extremely limited, perhaps it

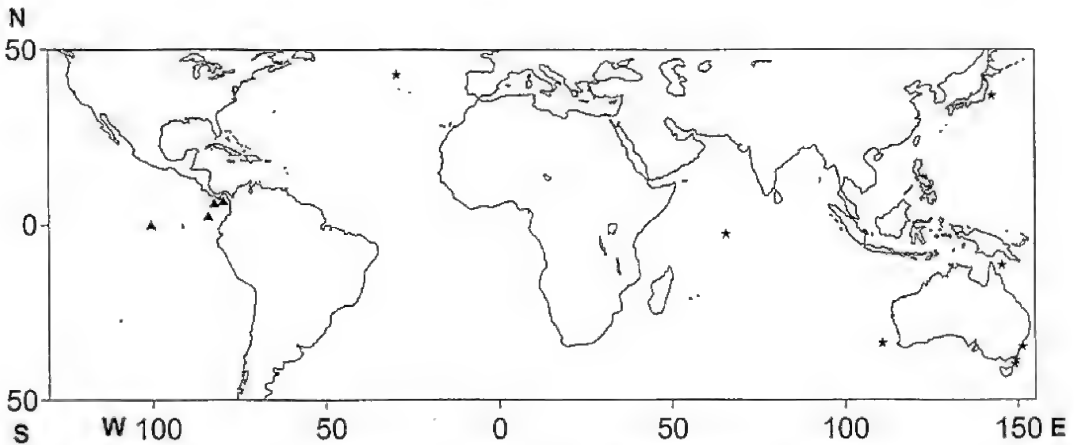


FIGURE 3. Known distributions of *Asthenomacrurus victoris* (stars) and *A. fragilis* (triangles).

could have been expected. The capture of a single specimen so distantly removed from its brethren in the Indian Ocean and western Pacific and its congener, *A. fragilis*, from the eastern central Pacific (see Fig. 3), echoes the original discovery of other benthic macrourids of the lower continental slope and rise, for example, *Macrormia phalacra* Merrett, Sazonov, and Shcherbachev, 1983, which was described from the northeastern Atlantic and the eastern Indian Ocean. That species has been subsequently recorded from the southwestern Pacific off Vanuatu (Merrett and Iwamoto 2000) and recently off Taiwan (Shao et al. [in press] 2008). Similarly, the genus *Paracetonurus* Marshall, 1973 (which is probably a synonym of *Pseudonezumia* Okamura, 1970) shows widely disjunct distributions of its two included species: *P. flagellicauda* Koefoed, 1927 from the Mid-Atlantic Ridge of the North Atlantic and the Madagascar Ridge in the southwestern Indian Ocean (Iwamoto and Orlov, 2006); and *P. occidentalis* (Iwamoto, 1979) from the eastern Pacific off Peru and California (Stein, 1985). We assume that most of these “rare” species are much more widely distributed than capture records show. It can be hoped that more exploratory trawling in the deep sea of the world oceans will add clarity to the distribution patterns of these species.

ACKNOWLEDGMENTS

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LITERATURE CITED

- BERGSTAD, O.A., G. MENEZES, AND Å.S. HØINES. 2008. Demersal fish on a mid-ocean ridge: distribution patterns and structuring factors. *Deep-Sea Research II*, 55(1–2):185–202.
- BERGSTAD, O.A., Å.S. HØINES, A. ORLOV, T. IWAMOTO, J. GALBRAITH, I. BYRKJEDAL, AND F. UIBLEIN. In press [2008]. Species composition and abundance patterns of grenadiers on the Mid-Atlantic Ridge between Iceland and the Azores. Pages 00–00 in A. Orlov and T. Iwamoto, eds., *Grenadiers of the World Oceans: Biology, Stock Assessment, and Fisheries*. American Fisheries Society: Bethesda, Maryland, USA.
- ESCHMEYER, W.N. 1998. *Catalog of fishes*. California Academy of Sciences: San Francisco. 2905 pp.
- GILBERT, C.H., AND C.L. HUBBS. 1916. Report on the Japanese macrourid fishes collected by the United States fisheries steamer "Albatross" in 1906, with a synopsis of the genera. *Proceedings of the U.S. National Museum* 51:135–214, pls. 8–11.
- IWAMOTO, T. 1979. Eastern Pacific macrourine grenadiers with seven branchiostegal rays. *Proceedings of the California Academy of Sciences*, ser. 4, 42(5):135–179.
- IWAMOTO, T., AND K.J. GRAHAM. 2001. Grenadiers (families Bathygadidae and macrouridae, Gadiformes, Pisces) of New South Wales, Australia. *Proceedings of the California Academy of Sciences*, ser. 4, 52(5):407–509.
- IWAMOTO, T., AND A. ORLOV. 2006. *Paracetomurus flagellicauda* (Koefoed, 1927) (Macrouridae, Gadiformes, Teleostei), new records from the Mid-Atlantic Ridge and Madagascar Plateau. *Proceedings of the California Academy of Sciences*, ser. 4, 57(11):379–386.
- IWAMOTO, T., AND YU. I. SAZONOV. 1988. A review of the southeastern Pacific *Coryphaenoides* (sensu) (Pisces, Gadiformes, Macrouridae). *Proceedings of the California Academy of Sciences*, ser. 4, 45(3):35–82.
- LEVITON, A.E., AND R.H. GIBBS, JR. 1988. Standards in herpetology and ichthyology: standard symbolic codes for institutional resource collections in herpetology and ichthyology. Supplement no. 1: additions and corrections. *Copeia* 1988(1):280–282.
- LEVITON, A.E., R.H. GIBBS, JR., E. HEAL, AND C.E. DAWSON. 1985. Standards in herpetology and ichthyology: part I. Standard symbolic codes for institutional resource collections in herpetology and ichthyology. *Copeia* 1985(3):802–832.
- MERRETT, N.R., AND T. IWAMOTO. 2000. Pisces Gadiformes: grenadier fishes of the New Caledonian region, southwest Pacific Ocean. Taxonomy and distribution, with ecological notes. Pages 723–781 in A. Crosnier, editor. Résultats des Campagnes MUSORSTOM, vol. 21. *Mémoires du Muséum national d'Histoire naturelle* 184.
- MERRETT, N.R., YU. I. SAZONOV, AND YU. N. SHCHERBACHEV. 1983. A new genus and species of rattail fish (Macrouridae) from the eastern North Atlantic and eastern Indian Ocean, with notes on its ecology. *Journal of Fish Biology* 22:549–561.
- SAZONOV, YU. I., AND YU. N. SHCHERBACHEV. 1982. Preliminary review of grenadiers related to genus *Cetomurus* (Gadiformes, Macrouridae). Descriptions of new taxa related to the genera *Cetomurus* Günther and *Kumba* Marshall. *Journal of Ichthyology* 22(5):707–721. [Also, in Russian, *Voprosy Ikhtiologii* 22(5)].
- SHAO, K.-T., T. IWAMOTO, H.-C. HO, T.-Y. CHIENG, AND C.-Y. CHEN. In press [2008]. Species composition and distribution pattern of grenadiers (family Bathygadidae, Macrouridae and Macrouridae) from Taiwan. Pages 00–00 in A. Orlov and T. Iwamoto, eds., *Grenadiers of the World Oceans: Biology, Stock assessment, and Fisheries*. American Fisheries Society: Bethesda, Maryland, USA.
- STEIN, D.L. 1985. Towing large nets by single warp at abyssal depths: methods and biological results. *Deep-Sea Research* 32:183–200.

Two New Australian Grenadiers of the *Coelorinchus fasciatus* Species Group (Macrouridae: Gadiformes: Teleostei)

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Coelorinchus maurofasciatus and *C. parvifasciatus* were originally described from New Zealand by McMillan and Paulin, 1993. The first species has been recorded as widespread around southern Australia, but close examination of specimens from the west coast has revealed them to be a closely similar but undescribed species. *C. parvifasciatus* was also reported from southeastern Australia, but comparison of many Australia and New Zealand specimens has shown that the Australian population represents a distinct and undescribed species. The two species are herein described as *Coelorinchus hoangi* and *C. gormani*, respectively. With the new species, Australia's grenadier fauna (including bathygadids, trachyrincids, macrouroidids and macrourids) now total 104 species, of which 22 are apparently endemic; 13 of the endemics are species of *Coelorinchus*.

The genus *Coelorinchus*¹ comprises more than 100 species whose distributions are primarily confined between lower-shelf and middle-slope depths of subtropical and tropical waters of the world's oceans. The greatest concentration of species lies in the broad region of the Indo-Australian Archipelago and the Philippines, with an extension out to the tropical western boundaries of the Pacific Ocean. A secondary area of species diversification appears in waters off New Zealand and southern Australia, where a primarily subtropical element resides. Most of this southern subtropical element consists of members of the *Coelorinchus fasciatus* species group, a clade defined by Iwamoto et al. (2004), which (with the inclusion of the species herein described) comprises 15 species whose distributions roughly coincide with the northern elements of the eastward-flowing Antarctic Circumpolar Current or West Wind Drift. The species of this clade are characterized by the combination of:

- (a) short, usually blunt snout, its length about equal to or usually shorter than the large orbit,
- (b) lateral and mesial processes of nasal bone not connected laterally,
- (c) dermal window of light organ well developed and placed variously from midway between the anus and the pelvic fins to between the pelvic fins.

¹ Eschmeyer (1990:70) incorrectly changed the spelling of the generic name from the previously used *Coelorinchus* to *Caelorinchus*, a spelling subsequently followed by Sazonov and Iwamoto (1992) and others. However, Dr. Dirk Nolf (*in litt.*), of the Institut Royal des Sciences Naturelles de Belgique, has made it clear that use of the diphthong oe in the name is correct. A return to the original spelling has been explained in FishBase and in a forthcoming publication (T. Iwamoto, Family Macrouridae, in K.E. Carpenter, editor, *FAO species identification guide for fishery purposes. The living marine resources of the eastern central Atlantic*).

- (d) body scales large, generally with 9 or more parallel rows (5–7 slightly divergent rows in *C. bollonsi*) of uniformly small spinules,
- (e) swim bladder divided into a single posterior chamber and a deeply bilobed anterior chamber, and
- (f) saddle or other body markings in most species.

Two new species belonging to the *C. fasciatus* group are here described from Australia. The first was previously included by Iwamoto and Williams (1999) in the similar *C. maurofasciatus*. It is known only from Western Australia (WA) and overlaps the range of the more widely distributed *C. maurofasciatus* along the southern coast of Western Australia (Fig. 1). The second species was treated by Iwamoto and Graham (2001) as *C. parvifasciatus* McMillan and Paulin, 1993, although differences between Australian and New Zealand specimens were discussed. It is now proposed that *C. parvifasciatus* is confined to New Zealand waters while a new sister species is described from southeastern Australian waters.

METHODS AND MATERIALS

Methods for taking counts and measurements and the abbreviations used are as described in Iwamoto and Sazonov (1988). Institutional abbreviations follow Leviton et al. (1985). Collection

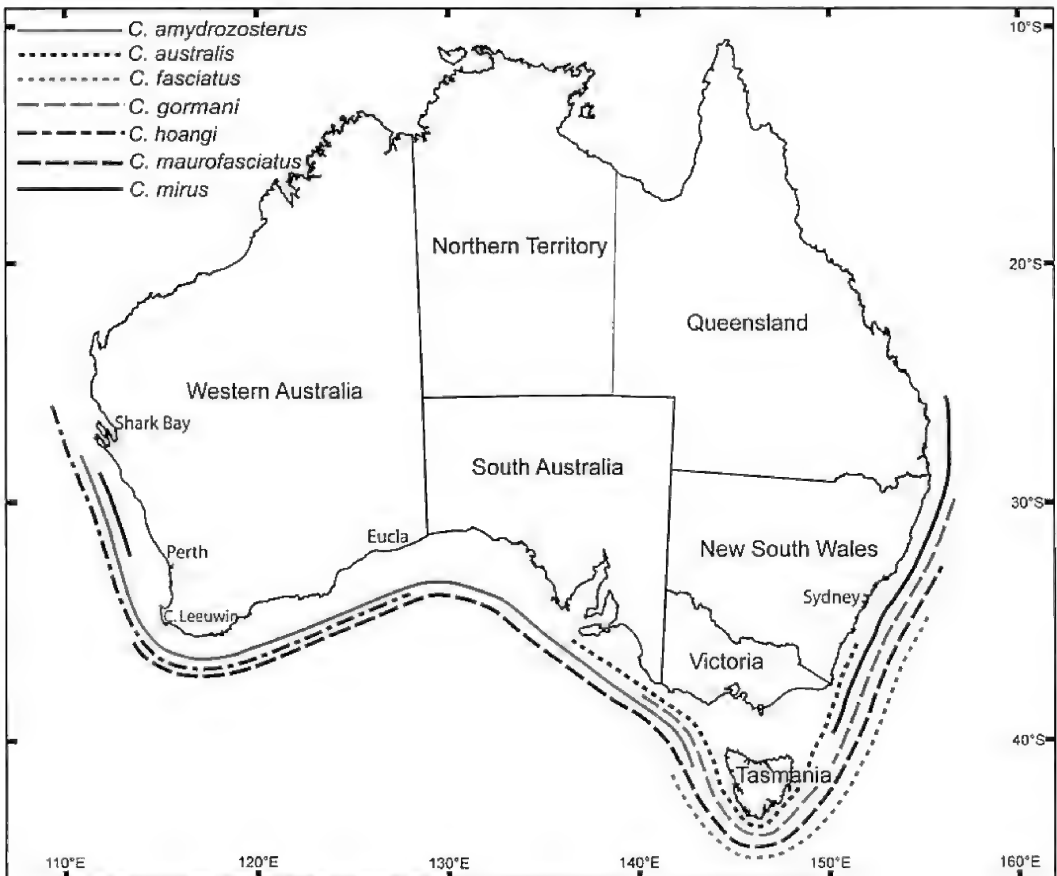


FIGURE 1. Distribution of the seven Australian species of the *Coelorinchus fasciatus* group.

data for stations of the FRV *Kapala* (abbreviated with a K followed by the last two digits of the year, the cruise number, and the drag number) are available in Iwamoto and Graham (2001).

DESCRIPTIONS

Diagnostic characters of the genus are described in Iwamoto (*in* Cohen et al., 1990:111–112). The *Coelorinchus fasciatus* species group is discussed in greater detail in Iwamoto et al. (2004: 193–194). Characters listed above for the species group are not repeated in the descriptions of the two new species unless they differed or needed further clarification.

Coelorinchus hoangi Iwamoto and Graham, sp. nov.

Figures 2, 3, 4 (*lower*), 8b.

Coelorinchus maurofasciatus (not of McMillan and Paulin, 1993) Williams et al., 1996:148 (WA distr.). Williams et al., 2001: Fig. 6 (WA). Iwamoto and Williams, 1999:150–152 (*in part*: WA specimens only).

DIAGNOSIS.—A species of the *Coelorinchus fasciatus* group (see characters of group above) with terminal snout scute small, broad, blunt. Underside of head completely naked; dorsal surface of snout behind leading edge almost fully scaled; nasal fossa usually partially scaled. Prominent saddle bands on body; anterior three pale interspaces between bands angled slightly posteroventrally from dorsal median line. Anal fin dusky overall, coarsely peppered with melanophores and lacking a dark distal stripe. Lens-shaped naked fossa of light organ about midway between anal and pelvic fins; pyloric caeca 17–23.

COUNTS AND MEASUREMENTS.—1D. 11,9–10; P. (rarely 116) 117–120; GR-I (inner) (1–2)+(6–7), 7–9 total, GR-II (outer/inner) 0+(6–7)/(1–2)+(6–7), 7–9 total; scales 1D.5.0–6.0, midbase 1D. 3.5–4.5, 2D. 4.0–5.5, lateral-line scales from anterior origin posteriorly over distance equal to length from snout tip to first dorsal fin 25–29; pyloric caeca 17–23 (\bar{x} = 19.8, SD = 1.3, N = 14).

Total length 160–283 mm; HL 36.9–63.3 mm. The following in percent of HL (exceptional measurements in parentheses): snout length 30–35; preoral length 28–34; internasal width 21–25;

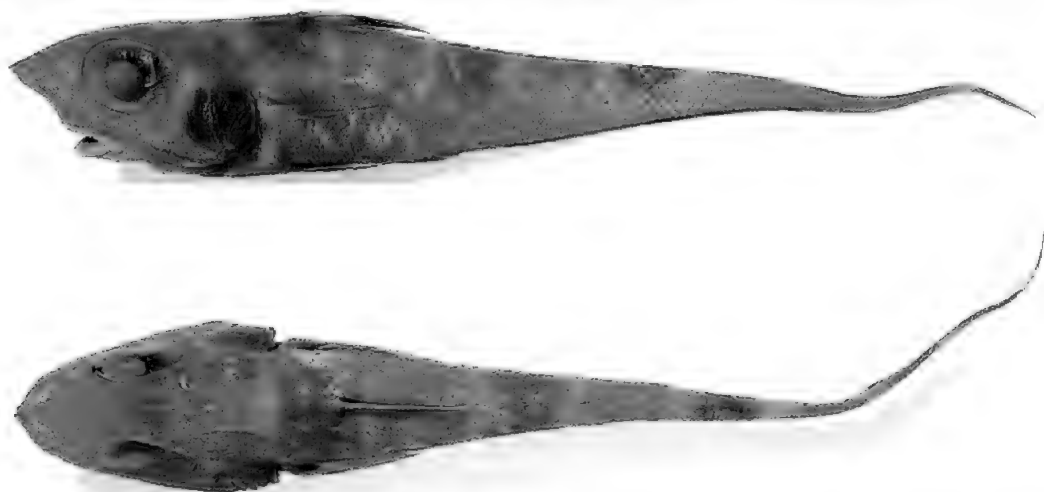


FIGURE 2. *Coelorinchus hoangi*, sp. nov. Holotype, CSIRO H2604-09 (227 mm TL) from Western Australia southwest of Ledge Point, in 512 m. Lateral view (upper); dorsal view (lower).

interorbital width 19–23; orbit diameter 37–40 (43); suborbital width 14–18; postorbital length 27–33; distance orbit to preopercle 29–35; length upper jaw 26–29; length barbel 9–13; length outer gill slit 12–15; pre-A. length (136) 141–163; length V.-A. 38–49; distance isthmus to A. (65) 69–90; body depth 56–73; 1D.-2D. interspace 19–27; height 1D. 51–67; length P. 47–54; length V. 40–53 (60); diameter posterior nostril 7–11; length dermal window of light organ 9–14.

DESCRIPTION OF HOLOTYPE (condition in other specimens in parentheses).— Head large,

broad, 4.5 (4.2–4.6) into TL; snout short, acutely pointed and moderately produced, but blunt when viewed dorsally; orbits large, oval, horizontal diameter slightly longer than snout length, 2.7 (2.5–2.7) in HL, anterodorsal margin entering dorsal profile; suborbital ridge well developed, dividing dorsal and ventral surfaces of head; subopercle weakly produced ventrally into a short flap; mouth small, premaxillary extends to below about midorbit; chin barbel short, thin.

First dorsal fin 61% of HL, less than postrostral length of head, 70% HL; spinous second ray about 0.5 mm shorter than adjacent segmented ray; second dorsal fin low to end of tail, where it meets anal fin; interspace between fins short, 21% HL, less than base of first dorsal, 27% HL. Anal fin well developed to end of tail. Base of pelvic fins below (slightly anterior to) origin of first dorsal fin; outer ray of fin prolonged, almost double length of second ray, extending posteriorly to fifth anal fin ray; second pelvic ray extending to origin of anal fin.

Terminal snout scute small, broad, blunt; ridges of head strong, stoutly armed with modified scutelike scales. Lunate dorsal areas behind leading edge of snout fully covered with small scales. Underside of head completely naked; nasal fossa partially scaled ventrally. Body scales large, adherent, covered with short, small spinules; scales below first dorsal with 9 or 10 (to 11 or more depending on size of fish) parallel to slightly divergent rows; scales on belly with 9 rows; a weak median-dorsal ridge on nape from supraoccipital scute to origin of first dorsal fin, formed by modified scales with somewhat higher and stouter median spinule rows.

Fossa of light organ, lens-shaped, naked, relatively small, about midway between anal and pelvic fins; anus immediately adjacent to origin of anal fin. Pyloric caeca long, slender, 21 in number.

Teeth all small, in bands in both jaws; premaxillary band short and broad, anterior teeth slightly longer than posterior and mesial teeth. Dentary band all small, broad anteriorly, tapering posteriorly.

Ground color in preserved specimen light brown to creamish, paler ventrally except light bluish to purplish over abdomen and posteriorly on chest, but pale along broad margin behind gill cover and anteriorly on chest; dark blue to blackish on opercular bones and branchiostegal membranes; black on inner side of pectoral fin base and ventral light organ; blackish in region of light

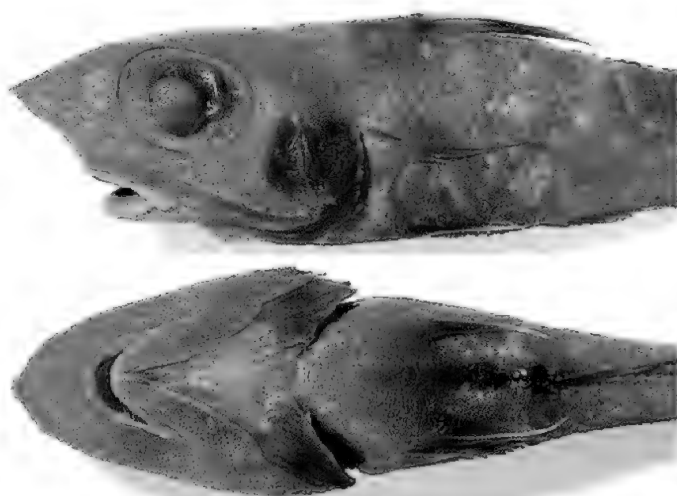


Figure 3. *Coelorinchus hoangi*, sp. nov. Holotype, CSIRO H2604-09. Close-up of lateral view of head and trunk (upper); close-up of ventral view of head and belly (lower).

organ and periproct. Anterodorsal edge of orbit blackish. Eleven (9–11) prominent dark to medium-brown saddle bands on body, the first narrow and faint, beginning at about supraoccipital scute and above opercle, the second beginning above pectoral fin base and terminating below anterior one-fourth of first dorsal fin, the third between dorsal-fin interspace, the second, fourth and sixth noticeably darker than first, third and fifth saddles; eleventh at posterior tip of tail; pale interspaces between saddles angled slightly posteroventrally from dorsal median line. Dark saddle pigmentation extends onto adjacent dorsal fin rays, although not readily apparent on preserved holotype (clearly present on dorsal and anal fins on recently preserved specimens, e.g., CSIRO H6376-03). First dorsal fin dusky to blackish, whitish on spinous second ray, paler near base and distal tip; anal fin dusky overall, coarsely peppered with melanophores and lacking a dark distal stripe; pelvic fins blackish, outermost ray whitish, fin paler distally. Oral and branchial cavities dark; inner lip of upper jaw black, lower pale. Underside of head with sparse scattering of relatively large melanophores. Scales covered with scattered melanophores; in areas of dark saddles, melanophores very small but dense; in pale interspaces and belly, melanophores relatively large but sparsely scattered.

SIZE.— To about 35 cm TL.

DISTRIBUTION.— From Shark Bay to Eucla, Western Australia (Fig. 1). Depth range 480–700 m.

ETYMOLOGY.— The new species is dedicated to friend and patron Tuan Hoang, M.D., for his long and enthusiastic support of ichthyology at the California Academy of Sciences.

COMPARISONS AND REMARKS.— *Coelorinchus hoangi* is closely similar to *C. maurofasciatus* McMillan and Paulin, 1993 and has been confused with that species. Saddle marks differ in minor but consistent ways between the two species: these differences are best seen in Fig. 4 where the pigmentation patterns in the two species are compared. The extent to which the first dorsal fin when laid down subtends the fourth saddle (the third saddle spans the interspace between the dorsal fins) differs: in *C. hoangi* the fin scarcely reaches beyond the anterior margin of the saddle, whereas in *C. maurofasciatus*, it extends well onto the saddle and sometimes beyond. In *C. maurofasciatus* the anal fin has a prominent black stripe over almost the entire length of fin; there is no such stripe in *C. hoangi*. Certain morphometric and meristic characters of *C. hoangi* and *C. maurofasciatus* are compared in Table 1. The new species attains a relatively small adult size, probably not much greater than 35 cm in TL (32 cm in largest specimen examined); in contrast, *C. maurofasciatus* exceeds 50 cm TL. The new species is known only from the west and southwest coasts of Australia from Shark Bay to Eucla, on the border of Western Australia and South Australia; *C. maurofasciatus* ranges across southern Australia from about Cape Leeuwin to central New South Wales, and also to northern and central New Zealand. The distributions of the two species overlap off the south coast of Western Australia.

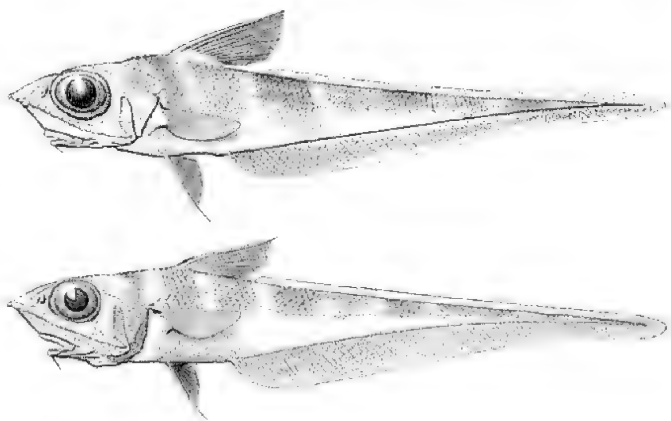


FIGURE 4. Stylized drawings of *Coelorinchus maurofasciatus* (upper) and *C. hoangi* (lower) to show differences in body pigmentation (saddles somewhat exaggerated).

The second new species described in this report, *C. gormani*, and *C. amydrozosterus* Iwamoto and Williams, 1999 are readily distinguished from *C. hoangi* by their fainter saddles (which are also oriented differently), usually paler body and fin pigmentation, and broad naked areas on dorsal snout surfaces behind the leading edges. *Coelorinchus hoangi* is distinguished from *C. fasciatus* by its more

TABLE 1. Comparison of selected measurements and counts for *Coelorinchus hoangi* and *C. maurofasciatus* (HL, head length; ADW, anterior dermal window; GR-I, gill rakers on first arch; SD, standard deviation).

	<i>C. hoangi</i>			<i>C. maurofasciatus</i>		
	range	mean (SD)	n	range	mean (SD)	n
Orbit diameter (%HL)	37–43	39.1 (1.6)	33	38–46	42.0 (1.8)	21
Barbel length (%HL)	9–13	11.4 (1.1)	18	10–16	12.4 (1.6)	19
Pelvic to anal fin (%HL)	38–45	43.5 (2.9)	17	34–44	39.8 (3.1)	18
Length pectoral fin (%HL)	47–53	50.5 (2.1)	15	53–61	56.2 (2.6)	21
Length pelvic fin (%HL)	48–63	51.8 (4.0)	17	51–59	54.4 (2.1)	21
Length ADW (%HL)	10–14	11.8 (1.1)	14	6–11	8.9 (1.6)	17
No. GR-I (inner)	7–9	8.4 (0.6)	17	7–9	8.4 (0.9)	13
Scales below 2D	4.0–4.5	4.6 (0.4)	17	4.0–4.5	4.3 (0.2)	19
Pyloric caeca	17–23	19.7 (1.3)	13	24–34	28.9 (4.0)	7

adherent scales (highly deciduous in *C. fasciatus*), absence of heavily modified predorsal scales with high median spinule ridges, paler median fins, slight differences in saddle marks, and smaller maximum size. In most characters, *C. hoangi* is most similar to *C. cookianus* McCann and McKnight from New Zealand, but that species has a larger, broader terminal snout scute, smaller scales (4.5–5.5 rows below midbase of first dorsal fin cf. 3.5–4.5, 29–32 lateral line scales over distance equal to predorsal length cf. 25–29), the second and third pale interspaces between saddle marks generally trend diagonally forward (vs. anteroventrally), and branchiostegal rays and subopercle are paler, without blackish pigmentation. Other species of the *C. fasciatus* group are readily differentiated by characters given in the key below.

TYPE SPECIMENS.— Holotype: CSIRO H2604-09 (50.3 mm HL, 227 mm TL); Western Australia, sw. of Ledge Point; 31°14.9'S, 114°52.3'E; 512 m; RV *Southern Surveyor* sta. SS11/91/70. Paratypes (33 specimens): AMS I.31171-009 (2: 45.3–51.6 HL, 210+197+ TL); 26°35.7'S, 112°29.0'E; 500–508 m; SS1/91/37. CSIRO H6376-03 (3: 59.5–73.2 HL, 247+–318+ TL); 29°01'S, 113°43'E; 680 m. NMV A9606 (6: 35.8–57.4 HL, 160–260 TL) and CSIRO H2591-15 (56.5 HL, 250 TL); 29°20.5'S, 113°58.3'E; 490–505 m; SS1/91/57. NMV A9660 (6: 38.5–63.3 HL, 168–282 TL); 30°00.0'S, 114°27.1'E; 480–490 m; SS1/91/65. CSIRO H2604-11 (49.3 HL, 215+ TL); same data as for holotype. NMV A9639 (6: 49.0–54.2 HL, 210–225 TL); 32°02.3'S, 114°54.5'E; 640–670 m; SS1/91/72. WAM 30495.001 (4: 219–235 TL); 34°43'S, 114°32'E, 625–630 m; 11 Jun 1992. NMV A6186 (172 TL); 35°26.3'S, 116°46'E; 606–671 m. CSIRO H6383-04 (2: 59.0–73.0 HL, 235+–313 TL); 35°22'S, 118°19'E; 680 m. AMS I.18711-020 (2: 52.5–52.9 HL, 210–209+ TL); 33°29'S, 127°15'E; 640–650 m; RV *Dmitry Mendeleev* sta. DM 1372; 28 Feb 1976. CSIRO H3025-06 (52.7 HL, 230 TL); 33°06'S, 114°30'E; 596 m.

***Coelorinchus gormani* Iwamoto and Graham, sp. nov.**

Figures 5, 10, 11

Coelorinchus sp. 3: McMillan, in Gomon et al. 1994:349, fig. 309 (as “Little Whiptail”).

Coelorinchus parvifasciatus (not of McMillan and Paulin, 1993): Williams and Bax 2001:536. Iwamoto and Graham, 2001:453–454, fig. 70 (NSW captures).

DIAGNOSIS.— A species of the *C. fasciatus* group with underside of head entirely naked. Snout blunt with broad naked areas dorsally behind leading edge; nasal fossa naked. Orbit diameter

44–49% of HL. Saddles obscure anteriorly, more prominent posteriorly on body; pale interspaces between saddles narrow, occupying one or two scale rows on dorsomedian line and giving appearance of white spots when viewed dorsally. All fins generally dark dusky to blackish. Naked fossa of light organ extends forward close to line connecting pelvic-fin insertions. Pyloric caeca 19–26. ($\bar{x} = 21.8$)

COUNTS AND MEASUREMENTS (see also table below).— 1D. 11, 9–11 (usually 10); GR-I (inner) (1–2)+(6–7), 7–9 total, GR-II (outer/inner) 0+(6–7)/(1–2)+(6–7); scales below 1D. 5.0–6.0, below midbase 1D. 3.5–4.5 (usually 4.5), below 2D. 4.5–5.5, lateral-line scales from origin posteriorly over distance equal to predorsal length 26–28.

Total length 145–260 mm; HL 27–56 mm. The following in percent of HL (exceptional measurements in parentheses): preoral length 28–34; internasal width 21–25; interorbital width 18–23; postorbital length 28–33; distance orbit to preopercle 29–35; length outer gill slit 12–16; pre-A. length 136–164; length V.-A. 34–49; length isthmus to A. 62–84; body depth 59–73; 1D.-2D. interspace (13) 15–25; height 1D. 57–80; length P. 45–61; length V. 48–59 (63); diameter posterior nostril 6–9; length dermal window of light organ 6–13.

DESCRIPTION OF HOLOTYPE.— Head length about five in TL, its greatest width 1.7 length and slightly more than greatest depth. Body relatively shallow, depth under origin of first dorsal fin about 1.6 into HL. Snout pointed in lateral view, broadly angular in dorsal view, tipped with a small, broad, blunt scute. Orbit huge, much greater than snout length, about 2.2 into HL; anterodorsal margin forms part of dorsal profile of head. Subopercle with a short ventral tab mostly hidden beneath slightly lobelike posteroventral margin of preopercle. A stout suborbital ridge running from tip of snout to preopercle, terminating in a sharp point; the ridge forming a sharp separation between scaled upper part and naked underside of head. Mouth small, inferior, end of premaxillary falling somewhat behind vertical of midorbit. A short, slender barbel under anterior end of lower jaw. Gill membranes broadly connected to isthmus, lacking a free posterior fold.

Teeth all small, in bands in both jaws. Premaxillary band short and broad, its length about half length of rictus; outer series of teeth very slightly larger than inner teeth. Dentary teeth all small, tooth band broad anteriorly, tapering posteriorly, ending at about end of rictus.

First dorsal fin high, longer than postrostral length (orbit plus postorbital length); second dorsal fin low anteriorly, increasing in height towards end of tail. Interspace between first and second dorsal fins shorter than base of first dorsal. Anal fin well developed to end of tail, where it is confluent with the second dorsal fin. Pectoral fins about 60% of HL; their upper margin situated below the midlateral line, about five scale rows below highest point of lateral line. Pelvic fins small, their

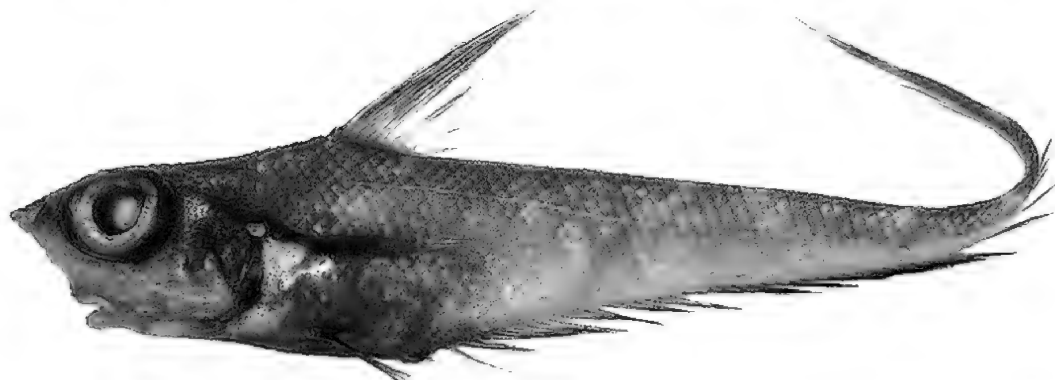


FIGURE 5. *Coelorinchus gormani*, sp. nov. Paratype, AMS I.26240-001, from east of Broken Bay, New South Wales, in 421–457 m.

origin behind that of pectoral fins, but anterior to that of first dorsal fin; outermost ray slightly prolonged extending to about sixth anal fin ray.

Body scales large, relatively adherent; large scales below first dorsal fin fully covered with 15–17 more or less parallel rows of short reclined spinules. Ridges of head marked by stout, coarse, scutelike scales, none of which are prominently enlarged. Underside of head naked. Lunate areas dorsally behind leading edge of snout broadly naked, but with a few scattered small, deeply embedded scales anteriorly. Nasal fossa naked.

Light organ manifested externally by an elongated black dermal window situated in a shallow medioventral fossa on belly between pelvic fins, about midway between inner bases of pelvic fins and anterior end of periproct. Anus ringed by narrow black margin of periproct, which lies immediately before anal fin; a small genital papillae at posterior margin of periproct.

Color in preservative grayish-brown overall, paler ventrally under head and tail, bluish over abdomen, blackish over opercle, subopercle, and part of preopercle. Chest area mostly swarthy but somewhat paler behind margin of gill membranes. Saddle marks or bands on body relatively faint, but about 11 or 12 saddles discernible, more prominent posteriorly, generally confined to dorsum above lateral midline, each separated by a narrow pale vertical interspace two or three scale rows wide. Banding pattern more prominent when viewed dorsally, with pale interspaces spot-like. Mouth and gill cavity blackish; lips pale except upper lips dark anteriorly; chin barbel pale. Base of pectoral fin black mesially, but completely lacking pigmentation on lateral face. Dorsal and pectoral fins dark dusky, but narrowly pale along base of each fin. A blackish blotch on pelvic fin, paler near base and near tip, with outermost elongated ray distally white. A dark stripe along middle of anal fin (in many paratypes anal fin dark dusky with little or no trace of a stripe).

SIZE.— To about 30 cm.

ETYMOLOGY.— Named after fishery scientist Terry Gorman who pioneered deepwater fishery research in Australia in the 1970s and 1980s with the New South Wales FRV *Kapala*; it was from collections made during this research that the extent of the southeast Australian grenadier fauna came to the attention of the authors.

DISTRIBUTION.— Southeastern Australia, from northern New South Wales (about 29°30'S) to eastern Victoria, eastern and western Tasmania, and western Victoria (Fig. 1). Williams et al. (1996: 148) listed this species from Western Australia (CSIRO H2604-02), but that specimen is a *C. amydrozosterus* Iwamoto and Williams, 1999. There are no confirmed records of *C. gormanii* west of the Victoria—South Australia border. The species is found in upper-slope depths from about 200 to 700 m, but primarily in 250–550 m.

REMARKS.— This is a species of relatively small size and possibly the most abundant *Coelorinchus* off NSW, and “an especially abundant species in trawl fish grounds off southwestern Victoria” (McMillan in Gomon et al. 1994:349).

COMPARISONS.— The new species agrees in most respects with the common New Zealand species *C. parvifasciatus* McMillan and Paulin, 1993, but the two differ in the ranges of certain measurements and counts, as seen in Table 2. The anterior dermal window of the light organ was generally larger in New Zealand specimens, but there was overlap in the proportional measurements of that structure. Finally, the new species completely lacks the one to three small scales commonly found in *C. parvifasciatus* on the ventral surface of the head above the articulation of the lower jaws (18 of 28 specimens of *C. parvifasciatus* we examined had one or more of these scales).

Of the sympatric Australian members of the group, *Coelorinchus gormanii* most closely resembles *C. amydrozosterus*, but that species has a more prominent and slightly different banding pattern, a much larger dermal window of the light organ, fewer pyloric caeca (15–17), and a distinct series of predorsal scales (with high median ridge). *Coelorinchus gormanii* is easily distinguished

TABLE 2. Comparison of selected measurements and counts for *Coelorinchus gormani*, *C. parvifasciatus*, and *C. amydrozosterus* (HL, head length; SD, standard deviation).

	<i>C. gormani</i>			<i>C. parvifasciatus</i>			<i>C. amydrozosterus</i>		
	range	mean (SD)	n	range	mean (SD)	n	range	mean (SD)	n
Pectoral fin rays	i17–i20	18.2 (0.9)	56	i15–i18	17.0 (1.0)	20	i15–i20	17.4 (1.1)	46
Pyloric caeca	19–26	21.8 (2.8)	28	22–28	25.3 (1.8)	11	13–16	14.7 (1.0)	7
Snout length (%HL)	27–31	29.3 (1.0)	28	27–34	30.6 (1.5)	20	29–34	31.4 (1.3)	25
Orbit diameter (%HL)	44–49	46.0 (1.6)	28	39–44	42.2 (1.2)	19	38–42	40.3 (1.4)	21
Suborbital width (%HL)	16–18	16.4 (0.7)	28	13–16	14.7 (0.8)	20	15–18	15.8 (0.9)	25
Upper jaw length (%HL)	26–33	28.0 (1.2)	28	22–29	26.3 (1.9)	20	28–31	29.2 (0.8)	24
Barbel length (%HL)	9–14	11.3 (2.5)	28	5–11	8.4 (1.1)	10	8–14	11.8 (1.8)	24

from *C. mirus* by the notably large dermal window of the light organ in that species (extends anteriorly onto the chest). It also differs from *C. maurofasciatus* and *C. fasciatus* in having less prominent saddle marks, spotlike pale markings along the dorsal midline of the tail, paler first dorsal and anal fins (without prominent markings), and broad naked areas behind the leading edge of the snout. *Coelorinchus australis* is strongly distinguished from the new species in having multiple longitudinal stripes on the body and scaled undersurface of head. The last four species also attain a much larger size than does the new species.

TYPE SPECIMENS.— Holotype: AMS I.20301-006 (39.0 mm HL, 190 mm TL); New South Wales e. of Woolli; 29°53'S, 153°42'E; 502 m; RV *Kapala* sta. K77-13-12; 23 Aug 1977. Paratypes: **New South Wales.** CAS 212159 (10: 35.1–57.2 HL, 170+–273+ TL); 36°46'S, 150°21'E; 521–567 m; FV *Shelley H.* AMS I.15968-013 (5: 37.0–56.3 HL, 155+–245+ TL); 33°42'S, 151°50'E; 366 m; K71-05-04. AMS I.15973-008 (3: 45.4–52.0 HL, 215+–255+ TL); 33°35'S, 152°01'E; 375–384 m; K71-07-03. AMS I.18838-017 (18: 28.1–55.2 HL, 150–270 TL); 33°04'S, 152°33'E; 448+466 m; K75-05-03. AMS I.18839-054 (34.0 HL, 155+ TL); 33°27'S, 152°05'E; 410 m; K75-05-04. AMS I.24127-001 (48.5 HL, 250 TL); 34°17'S, 151°26'E, 410 m; K75-05-02. AMS I.26240-001 (46.1 HL, 222+ TL); 33°36'S, 151°57'E; 421–457 m; K85-17-02. **Tasmania.** NMV A3756 (27: 33.6–53.0 HL, 124+–233+ TL) and CAS 68410 (formerly NMV A3754)(5: 29.5–49.1 HL, 145–218+ TL); 42°41.7'S, 148°24.9'E, 444–448 m; RV *Soela* SO5/84/70. **Victoria (western).** NMV A3408 (3: 35.5–44.3 HL, 180–225 TL); 38°40'S, 141°15'E; 293–329 m. NMV A2139 (2: 29.8–41.6 HL, 161–214 TL); 38°25'S, 140°41'E, 650–680 m; FV *Halcyon* [field no. MFG 113]; 26 Oct 1981.

NON-TYPE MATERIAL.— **New South Wales.** AMS I.15970-027 (4: 37.1–40.4 HL, 195–190 TL); 33°46'S, 151°52'E; 503 m; K71-06-04. AMS I.15975-036 (43.0 HL, 209+ TL); 33°14'S, 152°21'E; 549–567 m; K72-04-01. AMS I.16565-003 (34.0 HL, 162+ TL); 33°45'S, 151°49'E; 457 m; K72-04-01. AMS I.19205-003 (4: 44.2–50.5 HL, 227–255 TL); 33°30'S, 151°58'E; 375–384 m; K76-07-01. **Victoria (eastern).** AMS I.15994-007 (25: 29.5–48.6 HL, 211–238 TL) and NMNZ P.043187 (10: 41.8–51.8 HL, 210–240+ TL); 37°42'S, 150°14'E; 412–439 m; K71-13-02. AMS I.18774-001 (47.0 HL, 220 TL); 37°42'S, 150°15'E; 412–439 m; K75-03-02. **Tasmania.** CAS 79577 (formerly NMV A3752)(10: 30.8–42.3 HL, 153+–236 TL); 42°42'18"S, 148°25'24"E; 428–450 m; RV *Soela*.

DISCUSSION

These two new species are additional examples of grenadiers that had previously escaped recognition because of their close similarity to previously described ones. It was only after close examination of many specimens that consistent characters were found that distinguished these species from their closest counterparts. Differences in pigmentation patterns were the first characters to capture our attention, which is contrary to what one might expect from members of a fami-

ly that are usually drab and without prominent markings or color patterns. However, the shallow-water species of *Coelorinchus*, and especially members of the *C. fasciatus* group, often possess highly characteristic pigmentation. The patterns are frequently subtle, but once recognized, they are characters that one can dependably utilize to differentiate between otherwise similar species. It seems likely that other "cryptically" hidden species will be found among the grenadier fauna, and it is incumbent on investigators to examine species that may otherwise appear to have broad geographical or vertical distributions. *Coelorinchus fasciatus* and *C. mirus* are two such species requiring closer scrutiny. It is noteworthy that DNA barcoding of Australia's fishes for the mitochondrial gene COI (Ward et al., 2005) has produced a preliminary cladogram of *Coelorinchus*: four species (*C. hoangi*, *C. maurofasciatus*, *C. australis*, and *C. mirus*) of the *C. fasciatus* species group form a single clade with *C. hoangi* and *C. maurofasciatus* as sister taxa (R.D. Ward, pers. comm.). It is hoped that additional taxa can be analyzed soon to provide a more cohesive understanding of relationships within this large genus.

The diversity of the *C. fasciatus* species group and the relatively restricted ranges of most of the species are notable for the family. Of the 15 known species, only *C. fasciatus* can be considered as truly widespread, being known from Australia, New Zealand, and from both sides of the southern tip of South America (but, again, this should be looked at more closely). *Coelorinchus maurofasciatus* is found off both Australia and New Zealand, while five species are confined to Australia, seven to New Zealand, one to South Africa, and one to the southwestern Indian Ocean and southeastern Atlantic Ocean. Species in the group and their general distributions are (e., w., s., se. = eastern, western, southern, and southeast):

<i>C. amydrozosterus</i> Iwamoto and Williams, 1999	s. and w. Australia
<i>C. aspercephalus</i> Waite, 1911	New Zealand
<i>C. australis</i> Richardson, 1839	se. Australia
<i>C. biclinozonalis</i> Arai and McMillan, 1982	New Zealand
<i>C. bollonsi</i> McCann and McKnight, 1980	New Zealand
<i>C. cookianus</i> McCann and McKnight, 1980	New Zealand
<i>C. fasciatus</i> (Günther, 1878)	se. Australia, New Zealand, s. Chile and Argentina
<i>C. maurofasciatus</i> McMillan and Paulin, 1993	s. Australia and New Zealand
<i>C. mirus</i> McCulloch, 1926	e. and w. Australia
<i>C. mystax</i> McMillan and Paulin, 1993	New Zealand
<i>C. parvifasciatus</i> McMillan and Paulin, 1993	New Zealand
<i>C. sinorhynchus</i> Iwamoto and Anderson, 1993	s. Africa
<i>C. vityazae</i> Iwamoto, Shcherbachev, and Marquardt, 2004	sw. Indian Ocean
<i>C. hoangi</i> new species	w. Australia
<i>C. gormanii</i> new species	se. Australia

Of the 104 species of grenadiers now known to occur off Australia, 22 species are considered to be endemic. This represents a high percentage of endemics for a deep-sea fish group that was once thought to mostly comprise broadly distributed species. Various physical, biological, or historical factors have acted on this group to produce its high diversity, but what the specific factors were remain little known or mostly speculative.

A provisional key is provided below to facilitate identification of the included species. For the most part, proportional measurements were not used in preference to more visible and readily usable characters, but their use was unavoidable in the couplet where *C. parvifasciatus* and *C. gormanii* are separated (however, their geographic distributions are distinct). Counts of pyloric caeca are useful in differentiating some species, but overlap in counts among most species precludes their being used exclusively. A phylogenetic analysis of the clade has yet to be made: it would be instructive to determine if the species compose a cohesive group, and if so, to determine what species are the closest relatives.

Key to the Species of the *Coelorinchus fasciatus* Group

- 1a. Underside of head completely scaly. 2
- 1b. Underside of head mostly to fully naked, some species with isolated scales or patches of scales above and posterior to end of upper jaws (Fig. 6) 4
- 2a. Multiple narrow longitudinal stripes on dorsal aspects of body and part of head. *australis*
- 2b. No longitudinal stripes on body 3
- 3a. Two prominent saddle marks on body, one on nape anterior to first dorsal fin, the other below anterior end of second dorsal fin *biclinozonalis*
- 3b. Several faint diagonal bands on body oriented obliquely down and forward *aspercephalus*
- 4a. A small black spot at base of pectoral fin; a large black blotch on pelvic fin (Figs. 6, 7a); dermal window of light organ (ADW) notably large (Fig. 7a), extending forward beyond line connecting anterior ends of pelvic fin bases; underside of head behind upper jaws mostly scaled *mirus*
- 4b. No black spot on pectoral fin; pelvic fins lacking prominent black blotch (although middle of fin may be substantially darker than proximal and distal parts); ADW moderate to small, not extending forward beyond line connecting anterior ends of pelvic fin bases (Fig. 7b, c); underside of head naked or with small isolated scales 5
- 5a. Saddle marks or bands on body dark and prominent in some species, faint in other species. . 7
- 5b. No saddle marks on body. 6
- 6a. Body scales with 5–7 divergent rows of spinules; two small scale patches on ventral surfaces of preopercle, one above articulation of lower jaw, the other close to posterior margin of preopercle (Fig. 8) (saddles present on specimens <30 cm TL). *bollonsi*
- 6b. Body scales with as many as 15 parallel rows of spinules; underside of head naked, without scales *simorhynchus*
- 7a. Lips thick, heavily papillated; barbel well developed, 22–27% of HL, about equal to diameter of orbit; pyloric caeca more than 100 *mystax*
- 7b. Lips moderate, not heavily papillated; barbel generally short, less than 20% HL, much shorter than orbit diameter; pyloric caeca fewer than 40 8
- 8a. Snout tipped with a large, sharply pointed terminal scute, such that viewed dorsally, snout profile forms an acute angle (Fig. 9). *vityazae*
- 8b. Terminal snout scute broad and blunt; snout profile viewed dorsally forming an oblique angle 9
- 9a. The ADW relatively large, its anterior end at or just behind transverse line connecting inner edges of pelvic fin bases (Fig. 7c); several predorsal scales with sharp raised crests formed of enlarged spinules on median line; first dorsal and anal fins pale to dark dusky, without black blotches, margins, or stripes *amydrozosterus*
- 9b. The ADW small to moderate in size, not reaching transverse line through inner margins of pelvic fin bases; predorsal scales with or without enlarged ridgelike scales; first dorsal and anal fins variously pigmented. 10
- 10a. Body scales with 5–7 slightly divergent spinule rows; two small patches of scales on underside of head above and behind angle of jaws (Fig. 8). *bollonsi*

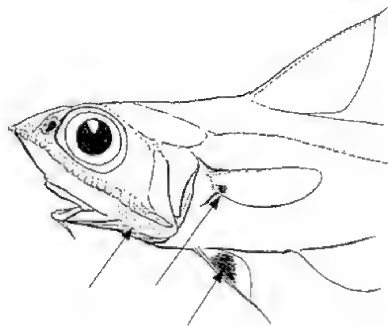


FIGURE 6. Lateral view of *Coelorinchus mirus*; arrows point out scaly underside of head behind vertical of upper jaws and black spots on pectoral and pelvic fins.

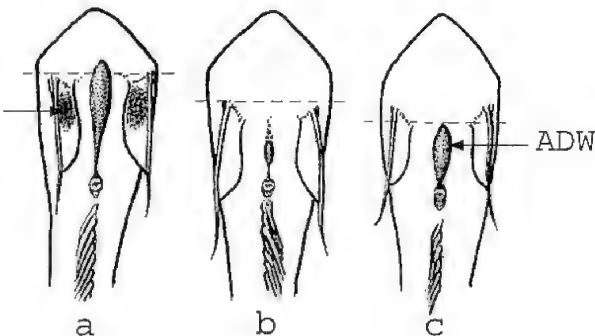


FIGURE 7. Ventral view of trunk of (a) *Coelorinchus mirus* showing large anterior dermal window of light organ (ADW) and large spot on pelvic fins; (b) *C. hoangi* showing size and position of ADW; (c) *C. amydrozosterus* showing size and position of ADW.

- 10b. Body scales with 7 or more parallel spinule rows; few isolated scales or none on underside of head 11
- 11a. Saddle marks faint or absent anteriorly; pale interspaces between saddles posteriorly on tail spot-like viewed dorsally (Fig. 10); broad areas on each side of midline dorsally behind leading edge of snout usually naked (Fig. 11), but sometimes scaly 12
- 11b. Saddle marks generally prominent from nape to tip of tail, pale interspaces not spotlike; areas dorsally behind leading edge of snout densely scaled 13
- 12a. Underside of head naked; pyloric caeca 19–26; orbit diameter 44–49% HL, suborbital 16–18% HL *gormanii*
- 12b. One or two small scale patches often present on underside of head; pyloric caeca 22–28; orbit diameter 31–46% HL, suborbital 13–16% HL *parvifasciatus*
- 13a. Scales on predorsal midline notably thick and elevated, with raised median crest of large spinules; body scales deciduous *fasciatus*
- 13b. Predorsal scales not notably thick or elevated; body scales relatively adherent 14
- 14a. Black distal two-thirds of first dorsal fin set off from paler proximal portions; dark anterior part of anal fin forming dark stripe *maurofasciatus*
- 14b. First dorsal fin light to dark dusky, not sharply set off into dark and pale regions; anal fin dusky to coarsely peppered, lacking dark stripe 15
- 15a. Branchiostegal rays and membranes pale; preopercle dark dorsally, subopercle paler; anal fin with dark stripe; scales below mid-base of first dorsal fin 4.5–5.5 (usually 5.5); pyloric caeca 19–27 *cookianus*
- 15b. Branchiostegal rays and membrane blackish; preopercle and subopercle blackish; anal fin usually uniformly dusky; scales below mid-base of first dorsal fin 3.5–4.5; pyloric caeca 17–23 *hoangi*

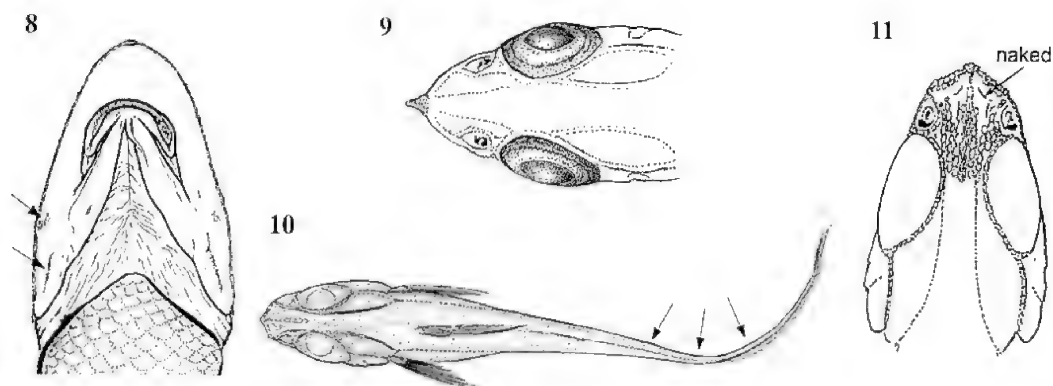


FIGURE 8. Ventral view of head of *Coelorinchus bollonsi* showing small scale patches above angle of lower jaws and on preopercle.

FIGURE 9. Dorsal view of head of *Coelorinchus vityazae* showing pointed snout

FIGURE 10. Dorsal view of *Coelorinchus gormani* new species showing pale spots on dorsum of tail.

FIGURE 11. Dorsal view of head of *Coelorinchus gormani* new species showing naked areas above snout.

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LITERATURE CITED

- COHEN, D.M., T. INADA, T. IWAMOTO, AND N. SCIALABBA. 1990. FAO species catalogue. Gadiform fishes of the world (Order Gadiformes). An annotated and illustrated catalogue of cods, hakes, grenadiers and other gadiform fishes known to date. *FAO Fisheries Synopsis* 10(125):1-442.
- ESCHMEYER, W.N. 1990. *Catalog of the Genera of Recent fishes*. California Academy of Sciences, San Francisco, California, USA. 697 pp.
- GOMON, M.F., J.C.M. GLOVER, AND R.H. KUITER, EDS. 1994. *The Fishes of Australia's South Coast*. State Print, Adelaide, Australia. 992 pp.
- IWAMOTO, T., AND K.J. GRAHAM. 2001. Grenadiers (families Bathygadidae and Macrouridae, Gadiformes, Pisces) of New South Wales, Australia. *Proceedings of the California Academy of Sciences*, ser. 4, 52(21):407-509, 114 figs.
- IWAMOTO, T., AND Y.I. SAZONOV. 1988. A review of the southeastern Pacific *Coryphaenoides* (sensu lato) (Pisces, Gadiformes, Macrouridae). *Proceedings of the California Academy of Sciences*, ser. 4, 45(3):35-82.
- IWAMOTO, T., Y.N. SCHERBACHEV, AND B. MARQUARDT. 2004. Grenadiers (Gadiformes, Teleostei) of Walters Shoals, southwestern Indian ocean, with description of a new "West-Wind Drift" species. *Proceedings of the California Academy of Sciences*, ser. 4, 55(10):190-207.
- IWAMOTO, T., AND A. WILLIAMS. 1999. Grenadiers (Pisces, Gadiformes) from the continental slope of western and northwestern Australia. *Proceedings of the California Academy of Sciences*, ser. 4, 51(3):105-243.

- LEVITON, A.E., R.H. GIBBS, JR., E. HEAL, AND C.E. DAWSON. 1985. Standards in herpetology and ichthyology: Part I. Standard symbolic codes for institutional resource collections in herpetology and ichthyology. *Copeia* 1985(3):802–832.
- McMILLAN, P.J., AND C. D. PAULIN. 1993. Descriptions of nine new species of rattails of the genus *Caelorinchus* (Pisces, Macrouridae) from New Zealand. *Copeia* 1993(3):819–840.
- SAZONOV, Y.I., AND T. IWAMOTO. 1992. Grenadiers (Pisces, Gadiformes) of the Nazca and Sala y Gomez ridges, southeastern Pacific. *Proceedings of the California Academy of Sciences*, ser. 4, 48(23):27–95.
- WARD, R.D., T.S. ZEMLAK, B.H. INNES, P.R. LAST, AND P.D.N. HEBERT. 2005. Barcoding Australia's fish species. *Philosophical Transactions of the Royal Society of London* B360:1847–1857.
- WILLIAMS, A., AND N.J. BAX. 2001. Delineating fish-habitat associations for spatially based management: an example from the south-eastern Australian continental shelf. *Marine and Freshwater Research* 52:513–536.
- WILLIAMS, A., P.R. LAST, M.F. GOMON, AND J.R. PAXTON. 1996. Species composition and checklist of the demersal ichthyofauna of the continental slope off Western Australia (20–35°S). *Records of the Australian Museum* 18:135–155.
- WILLIAMS, A., J.A. KOSLOW, AND P.R. LAST. 2001. Diversity, density and community structure of the demersal fish fauna of the continental slope off western Australia (20 to 35°S). *Marine Ecological Progress Series* 212:247–263.

The Flowering Plant Genus *Gaultheria* (Ericaceae) in the Gaoligong Shan, along the Border Region of China and Myanmar

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A taxonomic revision of the flowering plant genus *Gaultheria* (Ericaceae) in the Gaoligong Shan region of western Yunnan Province and extreme southeastern Xizang Province (Tibet) in China, and eastern Kachin State in northern Myanmar (Burma), is presented. Twenty-four species, three of which (*G. bryoides*, *G. notabilis*, and *G. pseudonotabilis*) are endemic, and two varieties (of *G. leucocarpa*) are recognized from the region. One new species (*G. bryoides*) is described from northern Myanmar, one new combination (*G. eciliata*) is made, and lectotypes are designated for *G. dumicola*, *G. forrestii*, *G. hookeri*, *G. repens*, *G. suborbicularis*, *G. tetramera*, and *G. veitchiana*. The treatment includes a key to species, descriptions, specimen citations, and images or illustrations of some species. Also included are species distribution maps based on estimates of geographic coordinates of old collections and GPS-derived coordinates of more recent collections.

KEYWORDS: Burma, China, Ericaceae, Gaoligong Shan, *Gaultheria*, Kachin, Myanmar, Taxonomy, Tibet, Xizang, Yunnan.

高黎贡山白珠属

本文对位于中国云南西部和西藏东南部至缅甸北方克钦邦东部的高黎贡山地区有花植物类群白珠属进行了系统修订。研究确认该地区有二十四种及两变种本属植物，其中含三个高黎贡山特有种 (*G. bryoides*, *G. notabilis*, 和 *G. pseudonotabilis*)，一个新组合 (*G. eciliata*)，并一个采自缅甸北部的新种 (*G. bryoides*)。并对全部二十四种中的七个种 (*G. dumicola*, *G. forrestii*, *G. hookeri*, *G. repens*, *G. suborbicularis*, *G. tetramera*, 和 *G. veitchiana*) 进行了模式选定。这一修订包括了分种检索表、文献引证、种的特征描述，以及根据目前可得到的全部新老标本资料估算得出的地理信息所绘制的种分布图。

关键词：高黎贡山、中国、云南、西藏、缅甸、克钦邦、杜鹃花科、白珠属、分类订正。

As part of a long-term, large-scale multidisciplinary biotic survey and inventory of the Gaoligong Shan (GLGS), we have begun to examine the taxonomy of several groups of vascular plants in this region for which we have expertise. The GLGS is a 600 km-long high-elevation mountain range that over much of its length straddles the border between China and Myanmar. The GLGS is situated at the heart of a vast biodiversity hotspot, i.e., a region of high levels of biodiversity under severe threat of destruction through human activity (Li et al. 2000; Stotz et al. 2003;

Liu and Kress 2005; Chaplin 2006). Our first treatment of GLGS vascular plants, that of the Symplocaceae (Zhou et al. 2006), served as a model for forthcoming treatments of other vascular plant groups of interest to us. Here, we follow up the treatment of Symplocaceae of the GLGS with one for the flowering plant genus *Gaultheria* Kalm ex Linnaeus.

Gaultheria contains about 135 species within the Ericaceae (heath family) distributed throughout eastern Asia and much of the Americas, with several species also in southern Australia, Tasmania, and New Zealand. The group includes species that are the original sources of wintergreen oil (methyl salicylate), commonly used in the confection industry and medicine. Several species of *Gaultheria* in the GLGS possess significant quantities of the oil (e.g., *G. fragrantissima*, *G. griffithiana*), and in these a strong wintergreen odor emanates from the leaves when they are crushed. The genus is distinctive among members of the Ericaceae by its fruit, a dry capsule or berry surrounded by a typically expanded and brightly colored fleshy calyx, which is presumably eaten by birds that disperse it.

Based on molecular data alone and in combination with morphology, Kron et al. (2002) have demonstrated that *Gaultheria* forms a clade with *Chamaedaphne* (Linnaeus) Moench, *Diplycosia* Blume, *Leucothoe* D. Don, and *Tepuia* Camp. This clade is thought to be diagnosable by 4-appendaged anthers and a base chromosome number of 11, although appendages have been modified or lost in some species, and *Diplycosia* has a base chromosome number of 9 or 18. The delimitation and relationships of both *Diplycosia* (ca. 100 species, Southeast Asia and Malesia) and *Tepuia* (seven species, northern South America) relative to *Gaultheria* are poorly understood, although there is evidence that at least several species of *Diplycosia* nest phylogenetically within *Gaultheria* (Powell and Kron 2001).

Airy Shaw (1941), based in part on the work of Copeland (1931), provided a classification of the Asian and temperate North American species of *Gaultheria*, dividing them into five sections and six series. Middleton (1991) incorporated most of Airy Shaw's scheme in his global classification of the genus, while altering some ranks and circumscriptions as needed. The GLGS species fall into four sections and six series of Middleton. Section *Chiogenopsis* D.J. Middleton, based on leaves usually less than 1 cm wide, two bracteoles inserted immediately beneath the calyx, solitary flowers, and glabrous corolla, includes series *Hispidulae* Airy Shaw (flowers tetramerous: *G. suborbicularis*) and series *Trichophyllae* Airy Shaw (flowers pentamerous: *G. cardiosepala*, *G. dolichopoda*, *G. hypochlora*, *G. nivea*, *G. sinensis*, *G. thymifolia*, and *G. trichophylla*; also *G. bryoides* and *G. eciliata*, not included in Middleton's account, can be included here). Section *Monoanthemona* D.J. Middleton, based on leaves more than 10 mm long, pluribracteolate pedicels, and solitary flowers, includes series *Nummularioideae* Airy Shaw (*G. nummularioides*). Section *Brossaeopsis* Airy Shaw, based on flowers in racemes and leaf venation melastomataceous, includes series *Dumicolae* Airy Shaw (raceme very short and flowers ca. 5 mm long: *G. dumicola* and *G. notabilis*) and series *Codonanthae* D.J. Middleton (raceme longer and corolla more than 10 mm long: *G. pseudonotabilis* can be placed here). Section *Brossaea* (Linnaeus) D.J. Middleton, based on flowers in racemes and leaf venation pinnate, includes the remainder of the GLGS species, all in two series of subsection *Botryphoros* D.J. Middleton: series *Gymnobotrys* (Airy Shaw) D.J. Middleton (raceme eperulate, slender, and usually geniculate: *G. leucocarpa*) and series *Leucothoides* (Airy Shaw) D.J. Middleton (raceme usually perulate, usually not slender or geniculate: *G. cuneata*, *G. discolor*, *G. fragrantissima*, *G. griffithiana*, *G. hookeri*, *G. praticola*, *G. pyrolifolia*, *G. semi-infera*, and *G. wardii*).

Prior taxonomic treatments of *Gaultheria* that include the GLGS region differ in various ways. Xu (1986a) recognized 19 species from Yunnan Province, and Xu (1986b) recognized 14 from Xizang Autonomous Region (Tibet). Xu (1991a, b) recognized 26 Chinese species for the *Flora*

Reipublicae Popularis Sinicae. Eight *Gaultheria* species with a distribution in China were subsequently described as new by Fang (1999), and these plus one other missed by Xu (1991a; *G. codonantha* Airy Shaw) were included in the treatment of the genus for the *Flora of China* (Fang and Stevens 2005). Eighteen species of *Gaultheria* were listed in Kress et al. (2003) for Myanmar (Burma), one of which (*G. stapfiana* Airy Shaw) was later reduced to synonymy by Fang and Stevens (2005; also listed is *Diplycosia discolor* Nuttall ex J.D. Hooker (= *G. discolor*) and *G. pyroloides* Miquel (a Japanese and Alaskan species)). The *Flora of Gaoligong Mountain* (Li et al. 2000), comprising a list of all vascular plant species in the GLGS known up to the time of its publication, included 20 species of *Gaultheria*, one of which (*G. forrestii* Diels) was later reduced to synonymy by Fang and Stevens (2005).

Our treatment modifies the above numbers of species of *Gaultheria* for particular areas in the following ways: 25 species known from Yunnan Province, 23 from Xizang Autonomous Region,

TABLE 1. Species richness and endemism of *Gaultheria*, by region. *, endemic. Those species bearing author names are not treated in this paper.

Region	No. species/ No endemics	Species
Yunnan	25/3	<i>G. cardiosepala</i> , <i>G. cuneata</i> , <i>G. discolor</i> , <i>G. dolichopoda</i> , <i>G. dumicola</i> , <i>G. eciliata</i> , <i>G. fragrantissima</i> , <i>G. griffithiana</i> , <i>G. hookeri</i> , <i>G. hypochlora</i> , <i>G. jingdongensis</i> R.C. Fang*, <i>G. leucocarpa</i> , <i>G. nivea</i> , <i>G. notabilis</i> *, <i>G. nummularioides</i> , <i>G. praticola</i> , <i>G. prostrata</i> , <i>G. pseudonotabilis</i> *, <i>G. pyrolifolia</i> , <i>G. semi-infera</i> , <i>G. sinensis</i> , <i>G. suborbicularis</i> , <i>G. thymifolia</i> , <i>G. trichophylla</i> , <i>G. wardii</i>
Xizang (Tibet)	23/4	<i>G. brevistipes</i> (C.Y. Wu & T.Z. Hsu) R.C. Fang*, <i>G. codonantha</i> , <i>G. cuneata</i> , <i>G. dolichopoda</i> , <i>G. eciliata</i> , <i>G. fragrantissima</i> , <i>G. griffithiana</i> , <i>G. heteromera</i> R.C. Fang*, <i>G. hookeri</i> , <i>G. hypochlora</i> , <i>G. nivea</i> , <i>G. nummularioides</i> , <i>G. praticola</i> , <i>G. purpurea</i> R.C. Fang*, <i>G. pyrolifolia</i> , <i>G. semi-infera</i> , <i>G. sinensis</i> , <i>G. straminea</i> R.C. Fang ¹ , <i>G. suborbicularis</i> , <i>G. thymifolia</i> , <i>G. trichophylla</i> , <i>G. trigonoclada</i> R.C. Fang*, <i>G. wardii</i>
China	34/14	<i>G. borneensis</i> , <i>G. brevistipes</i> *, <i>G. cardiosepala</i> , <i>G. codonantha</i> , <i>G. cuneata</i> *, <i>G. discolor</i> , <i>G. dolichopoda</i> , <i>G. dumicola</i> , <i>G. eciliata</i> , <i>G. fragrantissima</i> , <i>G. griffithiana</i> , <i>G. heteromera</i> *, <i>G. hookeri</i> , <i>G. hypochlora</i> , <i>G. jingdongensis</i> *, <i>G. leucocarpa</i> , <i>G. longiracemosa</i> Y.C. Yang*, <i>G. nivea</i> *, <i>G. notabilis</i> *, <i>G. nummularioides</i> , <i>G. praticola</i> *, <i>G. prostrata</i> *, <i>G. pseudonotabilis</i> *, <i>G. purpurea</i> *, <i>G. pyrolifolia</i> , <i>G. semi-infera</i> , <i>G. sinensis</i> , <i>G. straminea</i> ¹ , <i>G. suborbicularis</i> *, <i>G. taiwaniana</i> S.S. Ying*, <i>G. thymifolia</i> , <i>G. trichophylla</i> , <i>G. trigonoclada</i> *, <i>G. wardii</i>
Myanmar (Burma)	19/1	<i>G. bryoides</i> *, <i>G. cardiosepala</i> , <i>G. discolor</i> , <i>G. dolichopoda</i> , <i>G. dumicola</i> , <i>G. fragrantissima</i> , <i>G. griffithiana</i> , <i>G. hookeri</i> , <i>G. hypochlora</i> , <i>G. laxiflora</i> Diels, <i>G. leucocarpa</i> , <i>G. nummularioides</i> , <i>G. punctata</i> Blume, <i>G. pyrolifolia</i> , <i>G. semi-infera</i> , <i>G. sinensis</i> , <i>G. thymifolia</i> , <i>G. trichophylla</i> , <i>G. wardii</i>
Gaoligong Shan	24/3	<i>G. bryoides</i> *, <i>G. cardiosepala</i> , <i>G. cuneata</i> , <i>G. discolor</i> , <i>G. dolichopoda</i> , <i>G. dumicola</i> , <i>G. eciliata</i> , <i>G. fragrantissima</i> , <i>G. griffithiana</i> , <i>G. hookeri</i> , <i>G. hypochlora</i> , <i>G. leucocarpa</i> , <i>G. nivea</i> , <i>G. notabilis</i> *, <i>G. nummularioides</i> , <i>G. praticola</i> , <i>G. pseudonotabilis</i> *, <i>G. pyrolifolia</i> , <i>G. semi-infera</i> , <i>G. sinensis</i> , <i>G. suborbicularis</i> , <i>G. thymifolia</i> , <i>G. trichophylla</i> , <i>G. wardii</i>

¹Fang and Stevens (2005) considered *Gaultheria straminea* to be endemic to China, but the label information of the specimen *F. Kingdon Ward 8134* (K) states that this collection was from the Delei Valley in Assam, India.

34 species total from China, 19 species from Myanmar, and 24 from GLGS (Table 1). The GLGS harbors 23/34 (68%) of all *Gaultheria* species known from China, 18/19 (95%) of all *Gaultheria* species known from Myanmar, and 24/37 (65%) of all *Gaultheria* species known from the two countries combined. Adjacent regions have substantially fewer species of *Gaultheria*. For example, Sichuan Province has nine species, Guizhou Province three species, and Guangxi Province one species (Fang and Stevens 2005), Bhutan ten (Rae 1991), Nepal seven (Hara 1982) and all of Malaysia 24 (Sleumer 1966). Furthermore, all of the species from Guizhou, Guangxi, Bhutan, and Nepal also occur in the GLGS. Based on these data and data from other floras, it is clear that the GLGS lies at the heart of the major center of diversity for *Gaultheria* species in eastern Asia, possessing more species of this genus than any area of comparable size in either Asia or Malesia.

MATERIALS AND METHODS

The materials and methods generally follow those in “The Symplocaceae of Gaoligong Shan” (Zhou et al. 2006), with the following modifications. Approximately 1176 collections were studied, 835 of which were ultimately determined to originate from the GLGS. The material examined comprises the GLGS collections from KUN, the herbarium with the richest collection in SW China, and also those from A, BM, CAS, E, GH, K, and P. Some images of specimens from other herbaria (e.g., type specimens at L and NY) were examined via the World Wide Web, where noted.

Many of the collections have resulted from a biotic survey and inventory project primarily involving staff from KUN, CAS, and E, at which the first, second, and third sets from most of these expeditions, respectively, have been deposited. There have been 14 collecting expeditions undertaken in the context of this inventory (all planned expeditions with a vascular plant component for the project have now been carried out), and all specimens from these expeditions have been processed and accessioned at CAS and KUN for study. All of these expeditions use the same series of collecting numbers and are referred to herein as “GLGS” collections. The various teams collecting under this number series that appear on specimen labels are listed in Appendix 1, as are abbreviations for other major collectors or collecting teams (with ten or more *Gaultheria* collections) that have conducted expeditions to the Gaoligong Shan.

The number of synonyms is few in this work relative to that in Zhou et al. (2006) for *Symplocos*, and we have designated several lectotypes and made substantially more taxonomic changes than in Zhou et al. (2006). Thus, in contrast to Zhou et al. (2006), we include full citation of types for all synonyms.

Where a single measurement is used, it indicates length. Leaf blade measurements are from the larger leaves on each specimen. Leaf blade color and fruiting calyx lobe shape were assessed in the dry state. Anthers were measured from the base to the terminal pores (i.e., excluding awns).

The Chinese names of taxa are from Xu (1981, 1986a), Fang (1999), and Fang and Stevens (2005). New Chinese names are published here for *Gaultheria bryoides* (拟苔藓白珠), *G. discolor* (苍白叶白珠), *G. eciliata* (须毛白珠), and *G. thymifolia* (细叶白珠) because there are no current Chinese names available for these taxa.

For a map of Chinese counties (Xian) and Myanmar Districts included in the GLGS region cited in this work, see Zhou et al. (2006: Figure 3). For the present paper, we employ the spellings for Myanmar townships from Global Administrative Areas (GADM version 0.6 <http://biogeo.berkeley.edu/gadm/>) in the file Mmr4.shp. A list of species recognized, and an index to exsiccatae that we have examined for this study, are provided in Appendices 2 and 3. It is unclear from some label data whether collections made before the year 1949 with a locality of Gongshan Xian or Tsarong Xiang in Zayü Xian were made on the west (i.e., within the GLGS) or east (i.e.,

outside of the GLGS) side of the Nujiang. We chose to include such specimens in our treatment. The data on the labels of a few GLGS team collections conflict for county and township versus geographic coordinates due to uncertainty in the field as to the location of the county border (particularly at the southern end of Fugong Xian). In these cases, we cite the specimens in their correct county and township but indicate the mistake on the labels in brackets. It is unclear from label information whether many of the collections from Fugong Xian (including the former Bijiang Xian, which is now part of Fugong Xian) were from the east or west side of the Nujiang, although most were probably from the east side. We have included these collections in the citations but have not plotted them on the maps. A number of collections have a locality with the name "Hpimaw" in Myanmar (i.e., *R.J. Farrer* 895, 990, 1068; *Sukoe* 10080; *F. Kingdon Ward* 1691), which we interpret as the same name as "Pianma" in Lushui Xian of Yunnan, China. Similarly, we interpret localities with the name "Hpimaw Pass" in Myanmar as the same name as "Pianma Pass" at the crest of the GLGS in China.

TAXONOMIC TREATMENT OF *GAULTHERIA*

***GAULTHERIA* Kalm ex Linnaeus, Sp. Pl. 1:395. 1753.**

TYPE: *Gaultheria procumbens* Linnaeus.

Brossaea Linnaeus, Sp. Pl. 2:1190. 1753.

Chiogenes Salisbury, Trans. Hort. Soc. London 2:94. 1817. = *Glyciphylla* Rafinesque, Am. Month. Mag. 4:192. 1819.

= *Phalerocarpus* G. Don, Gen. Syst. 3:841. 1834.

= *Lasierpa* Torrey, Geol. Rep. New York, 152. 1839.

Shrubs, erect to prostrate, terrestrial or rarely epiphytic, evergreen, hermaphroditic, dioecious, or gynodioecious; indumentum of simple, unicellular or multicellular eglandular or gland-tipped trichomes; terminal buds abortive, axillary buds with numerous (GLGS) imbricate scales. Stipules absent. Leaves spirally arranged (GLGS), simple, petiolate, sometimes with strong wintergreen odor when crushed; leaf blade venation of major secondary veins usually pinnate or occasionally 2 originating at or near base on either side of midvein, margin usually serrate or crenate with teeth glandular- or trichome-tipped, apex glandular-tipped or -mucronate (GLGS). Inflorescences axillary racemes or solitary flowers (GLGS), sometimes bud stage appearing in autumn. Flowers actinomorphic. Pedicel articulated with calyx and when inflorescences racemose subtended by a \pm cucullate bract; bracteoles 2 and opposite or rarely several and \pm alternate (GLGS), \pm cucullate. Calyx synsepalous, lobes (4)5. Corolla green, white, pink, or red, sympetalous, urceolate to campanulate (GLGS), lobes (4)5. Stamens (2–6, 8)10, free from the corolla, distinct, straight, included, replaced by filamentous staminodes in female flowers with or without anther-like structures; filaments flattened, papillose (GLGS), dilated medially or submedially, nearly equal; anthers inverting during development, 2-locular, each locule opening by a pore that can include a short ventral slit (GLGS), with white disintegration tissue present dorsally along connective, 1 or 2 awns present per locule (GLGS) (if 1 then sometimes bifurcate). Nectary disk with ca. 10 deltoid or subulate lobes. Gynoecium (2–4)5(6)-carpellate; ovary superior or rarely slightly inferior, ovules 5–10 or numerous per locule; style 1, simple, columnar, hollow; stigma truncate. Fruit a globose capsule (GLGS) dehiscing loculicidally (GLGS) or irregularly, or a berry; receptacle and calyx dark purple, blue, pink, red, or white, accrescent, usually fleshy or rarely thin. Seeds numerous per fruit, ca. 1–1.5 mm in diam., angled; testa of \pm isodiametric to slightly elongated cells. $2n = 22, 24$, or 26 , or polyploid based on $n = 11$ or 12 .

A genus of ca. 135 species widely distributed in E and S Asia, SE Australia (including Tasmania), North and South America, and New Zealand; 34 species in China, 14 endemic; ca. 19 species in Myanmar, 1 endemic; 24 species in the GLGS, 3 endemic (numbers from Fang and Stevens (2005) and Kress et al. (2003), as modified on the basis of the present treatment).

Key to Species of *Gaultheria* in the Gaoligong Shan

* indicates species with two entries in key

- 1a. Inflorescences always 1-flowered; larger leaf blades $0.15\text{--}1.5 \times 0.08\text{--}0.85$ cm ($0.6\text{--}2.1 \times 0.5\text{--}1.9$ cm in *G. nummularioides*).
 - 2a. Bracteoles more than 2, not apical; corolla inside pubescent; filaments pubescent; anthers $1.3\text{--}1.5$ mm 15. *G. nummularioides*
 - 2b. Bracteoles 2, apical; corolla and filaments glabrous; anthers $0.3\text{--}1.1$ mm.
 - 3a. Branchlets long-trailing; calyx lobes and corolla lobes 4; corolla $2\text{--}3$ mm; anthers $0.3\text{--}0.5$ mm; style $0.6\text{--}0.8$ mm; calyx at fruiting red 21. *G. suborbicularis*
 - 3b. Branchlets not long-trailing; calyx lobes and corolla lobes 5 (rarely 4 in *G. hypochlora* and *G. sinensis*); corolla $3\text{--}5.5$ mm; anthers $0.5\text{--}1.1$ mm; style $0.9\text{--}3$ mm; calyx at fruiting blue, white, or rarely pinkish white or pink.
 - 4a. Leaf blade margin teeth villous-setose-tipped 23. *G. trichophylla*
 - 4b. Leaf blade margin teeth setulose-tipped.
 - 5a. Some or all leaf blades abaxially pubescent at least along midvein.
 - 6a. Calyx lobes deltoid to narrowly ovate-deltoid; stamen filaments $1\text{--}1.3$ mm, gradually dilated medially from apex; larger leaf blades oblanceolate, suborbicular, or rarely elliptic, abaxially often whitish green 11. *G. hypochlora*
 - 6b. Calyx lobes broadly ovate-deltoid; stamen filaments $0.6\text{--}1.2$ mm, \pm dilated medially, sides convex-curved; larger leaf blades elliptic to oblanceolate, light green to light brown 20. *G. sinensis*
 - 5b. Leaf blades always abaxially glabrous.
 - 7a. Leaf blade $1.5\text{--}2.2 \times 0.8\text{--}1$ mm, margin entire or with $1\text{--}3$ teeth per side and usually involute; calyx at fruiting not fleshy 1. *G. bryoides*
 - 7b. Leaf blade $3.5\text{--}15 \times 1\text{--}4$ mm, margin serrate with $3\text{--}15$ teeth per side and planar to slightly revolute; calyx at fruiting fleshy.
 - 8a. Pedicel $9\text{--}13$ mm; bracteoles $0.5\text{--}1(-1.2) \times 0.5\text{--}0.7(-1.4)$ mm 5. *G. dolichopoda*
 - 8b. Pedicel $1\text{--}5$ mm; bracteoles $1\text{--}4 \times 1\text{--}3$ mm.
 - 9a. Calyx lobes $1.3\text{--}1.8$ mm, overlapping at base, apex bluntly acute; style $0.9\text{--}1.1$ mm; calyx at fruiting blue ... 7. *G. eciliata*
 - 9b. Calyx lobes $2\text{--}3$ mm, not overlapping at base, apex acuminate; style $1.5\text{--}3$ mm; calyx at fruiting white, pinkish white, or pink.
 - 10a. Shrublets prostrate; leaf blade elliptic; calyx $2.5\text{--}3$ mm 13. *G. nivea*
 - 10b. Shrublets decumbent; leaf blade oblanceolate, linear-oblanceolate, or oblong-oblanceolate; calyx $3\text{--}3.5$ mm.
 - 11a. Shrublets $10\text{--}30$ cm tall; larger leaf blades $8.5\text{--}13$ mm; corolla urceolate, lobes $0.6\text{--}0.8$ mm; anther awns $0.5\text{--}0.6$ mm; style $2.5\text{--}3$ mm 2. *G. cardiosepala*

- 11b. Shrublets 2.5–10 cm tall; larger leaf blades 5–8.5 mm; corolla campanulate, lobes 1–2.5 mm; anther awns 0.2–0.3 mm; style ca. 1.5 mm22. *G. thymifolia*
- 1b. Some or all inflorescences 2- or more-flowered; larger leaf blades 1.4–17 × 0.7–9.7 cm.
 - 12a. At least one secondary vein on each side of leaf blade arising at or near base of blade and extending to apex or nearly so.
 - 13a. Leaf blade secondary veins 2–4 on each side of midvein, margin with 10–25 teeth per side; rachis and pedicels hirsute or lanate; bracteoles apical; corolla urceolate, villous inside4. *G. discolor*
 - 13b. Leaf blade secondary veins 1 or 2 on each side of midvein, margin with 25–many teeth per side; rachis and pedicels glabrous or puberulent; bracteoles basal; corolla campanulate, glabrous.
 - 14a. Plants to 0.4 m tall; leaf blade to 3.4 cm14. *G. notabilis*
 - 14b. Plants 0.6 m tall or more; leaf blade 5–16 cm.
 - 15a. Branchlets glabrous or at most puberulent; bracts 1.3–2.3 mm; calyx 2.2–2.6 mm; corolla 3–4 mm; capsule 3–6 mm in diam., strigillose-hirtellous6. *G. dumicola*
 - 15b. Branchlets setose-hirsute (as well as puberulent); bracts 2.5–8 mm; calyx 4–6 mm; corolla 6–15 mm; capsule 7–11 mm in diam., glabrous17. *G. pseudonotabilis*
 - 12b. Secondary veins all arising along midvein with proximal veins becoming faint or anastomosing before reaching apex.
 - 16a. Base of leaf blade cordate to auriculate-cordate12. *G. leucocarpa*
 - 16b. Base of leaf blade cuneate to rounded, occasionally subtruncate or subcordate.
 - 17a. Leaf blade abaxially appressed-stipitate-glandular.
 - 18a. Leaf blade adaxially puberulent on midvein and usually stipitate-glandular; bracts 1.2–2.5 mm wide; style 2.5–4 mm; calyx at fruiting white to red, lobes incurved; capsule sericeous3. *G. cuneata*
 - 18b. Leaf blade adaxially glabrous; bracts 2–3.5 mm wide; style 2–2.5 mm; calyx at fruiting dark purple, lobes ± erect; capsule glabrous or sparsely puberulent18. *G. pyrolifolia*
 - 17b. Leaf blade abaxially gland-dotted or variously pubescent but not stipitate-glandular.
 - 19a. Branchlets glabrous or occasionally sparsely setulose (or puberulent or both).
 - 20a. Leaf blade margin with 40–75 teeth per side, apex narrowly acuminate to caudate; corolla glabrous; anther awns 0.7–1.1 mm; fruiting calyx thin9. *G. griffithiana*
 - 20b. Leaf blade margin with 20–40 teeth per side, apex obtuse to acuminate; corolla pubescent inside; anther awns 0.4–0.8 mm; fruiting calyx fleshy.
 - 21a. Inflorescences generally from both upper and lower leaf axils, also often borne below the leaves; bracts narrowly deltoid, keeled; bracteoles subapical or usually apical; filaments sparsely pilose; anthers 1.3–1.5 mm8. *G. fragrantissima*
 - 21b. Inflorescences generally from the upper leaf axils; bracts elliptic to suborbicular, not keeled; bracteoles ± medial; filaments glabrous; anthers 0.7–1.3 mm10. *G. hookeri**

- 19b. Branchlets evenly scattered to densely setose, setose-hirsute, villous-hirsute, or pilose-villous (and often puberulent).
- 22a. Bracts ovate, elliptic, or suborbicular, apex rounded, acute, or rarely (in some *G. hookeri*) shortly acuminate.
- 23a. Plants 30–300 cm tall, erect to occasionally \pm prostrate, stems branched, branchlets not notably elongate; leaf blade 1.7–3.8 \times as long as wide; inflorescences 7–24-flowered; corolla 1.8–4 mm wide; calyx at fruiting blue or blue flushed with white, lobes \pm erect with margin pale-edged10. *G. hookeri**
- 23b. Plants 15–30 cm tall, prostrate to decumbent, stems unbranched or branchlets elongate; leaf blade 1.1–2.2 \times as long as wide; inflorescences 1–6-flowered; corolla 4.5–6 mm wide; calyx at fruiting black, lobes incurved with margin not pale-edged16. *G. praticola*
- 22b. Bracts deltoid, deltoid-ovate, rhombic-lanceolate, or linear-lanceolate, apex sharply acute to aristate.
- 24a. Branchlets not notably elongate; bracts 1.2–3.7 mm; bracteoles apical or subapical; stamens 2–819. *G. semi-infera*
- 24b. Branchlets elongate; bracts 4–6 mm at least proximally along inflorescence; bracteoles \pm medial; stamens 1024. *G. wardii*

1. *Gaultheria bryoides* P.W. Fritsch & L.H. Zhou, sp. nov. Type.— MYANMAR. Kachin: [Putao District. Nogmung Township], Nam Tamai Valley [Gaoligong Shan], 1937–1939, *F. Kingdon Ward 13216a* (holotype: BM!).

Hace species *Gaultheria dolichopoda* similis, sed petiolo 0.7–1.5 mm longo, lamira elliptica 1.5–2.2 \times 0.8–1 mm, margine integro vel 1–3-dens in quoque latere et plerumque involuto differt.

Shrublets, prostrate. Branchlets elongate, densely reddish brown-uncinate-setulose and white-puberulent. Petiole 0.2–0.3 mm, glabrous; leaf blade elliptic, 1.5–2.2 \times 0.8–1 mm, gradually smaller along stems toward both ends of each year's growth, 1.9–2.6 \times as long as wide, subcoriaceous, \pm glossy, abaxially greenish brown, adaxially dark greenish brown, both surfaces glabrous or midvein occasionally adaxially sparsely puberulent toward base, midvein abaxially raised and adaxially planar or obscure, secondary and tertiary veins obscure, base cuneate to subrounded, margin entire or serrate, with 1–3 shortly setulose-tipped teeth per side, slightly thickened, often involute to occasionally planar, apex acute. Inflorescences axillary, 1-flowered; bracts absent. Flowers unknown. Pedicel ca. 0.8 mm, glabrous; bracteoles 2, apical, oblong-ovate, not keeled, 0.5–1 \times 0.5–0.8 mm, persistent, glabrous, margin entire, apex broadly obtuse to rounded. Calyx at fruiting probably white, not fleshy; lobes erect or incurved, not pale-edged, apex long-acute to acuminate. Capsule ca. 3.5 mm in diam., glabrous; fruiting style ca. 1.5 mm, glabrous.

This new species, clearly a member of *Gaultheria* ser. *Trichophyllae* Airy Shaw, is easily distinguished from all other species of Asian *Gaultheria* by its minute leaf blades (1.5–2.2 \times 0.8–1 mm). It appears to be unique among the species of the series also in its non-fleshy fruit. It is thus far known to us only from the type. The species is named for its moss-like appearance.

The specimen label of the holotype indicates that it was separated from the collection *F. Kingdon Ward 13216*. The label indicates that the collection from which it was separated was *Meconopsis speciosa* Prain, but further investigation has revealed that the original determination list at BM of the collections of F. Kingdon Ward has designated 13216 as a specimen of *Saxifraga calciccola*

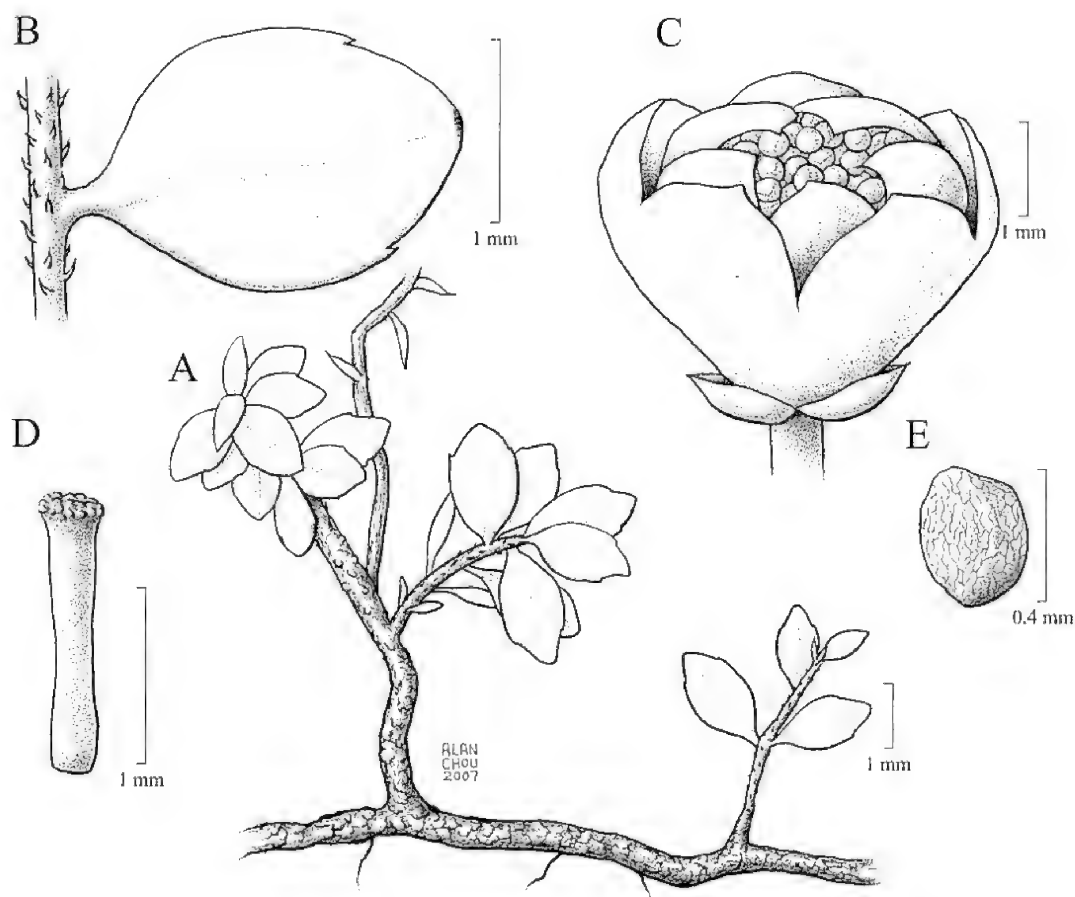


FIGURE 1. *Gaultheria bryoides*. A. Whole plant. B. Branchlet and leaf (abaxial view). C. Fruit. D. Style. E. Seed. Based on *Kingdon Ward 13216a* (BM).

J. Anthony, with the following collection information: Nam Tamai Valley, 28°N, 97°45'E, 9000–11,000 ft., 10 September, 1937 (J. Gregson, pers. comm.). Thus, this collection information, although not on the label, can probably be considered applicable to the holotype of *G. bryoides*.

ILLUSTRATION.— Figure 1.

PHENOLOGY.— Fr. Sep.

DISTRIBUTION AND HABITAT. — 2700–3300 m. In GLGS: MYANMAR. Kachin: Putao District (Nogmung Township); Figure 2. Endemic to GLGS.

CHINESE NAME.— 拟苔藓白珠 (新拟) ni tai xian bai zhu

2. *Gaultheria cardiosepala* Handel-Mazzetti, Anz. Akad. Wiss. Wien, Math.-Naturwiss. Kl. 60:185. 1923. SYNTYPES.— CHINA. Yunnan: Montis Dji-schan ad bor.-occ. urbis Dali (Talifu), 3350 m, 21 May 1915, *H.F. v. Handel-Mazzetti* 6416 (?W, E!, K!); — CHINA. Xizang: Prope fines Tibeto-Birmanicas inter fluvios Lu-djiang (Salween) et Djiou-djiang (Irrawadi orient. super.), in glarea granitica ad rivum supra vicum Schutsche ad flumen Irrawadi [Gaoligong Shan], 24°58'N, 3000–3350 m, 9 July 1918, *H.F. v. Handel-Mazzetti* 9441 (?W, A!) [specimen at A = *G. thymifolia*, see below].

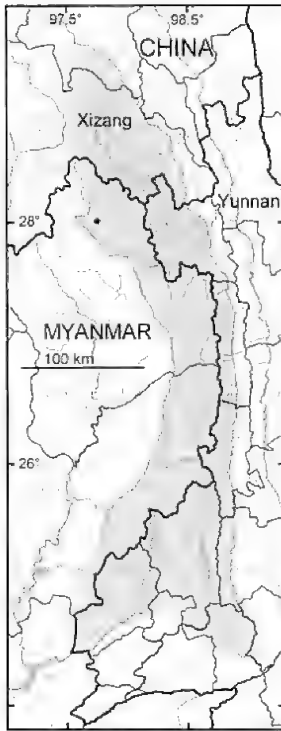


FIGURE 2. Distribution map of *Gaultheria bryoides* in the GLGS region.

Shrublets 10–30 cm tall, decumbent, gynodioecious. Branchlets elongated, terete, densely red-, ferruginous-, brown-, or black-uncinate-setulose and often white-puberulent. Petiole 0.4–1.2 mm, glabrous or occasionally adaxially puberulent; leaf blade oblanceolate, oblong-oblanceolate, or linear-oblanceolate, 8.5–13 × 2–3.5 mm, gradually smaller along stems toward both ends of each year's growth, 3–6 × as long as wide, coriaceous, abaxially dull light green to light brown with glossy edge, adaxially ± glossy green to brown, both surfaces glabrous or midvein occasionally puberulent adaxially toward base, midvein abaxially prominent and adaxially sulcate, secondary and tertiary veins obscure, base cuneate, margin serrate, with (4–)6–15 setulose-tipped teeth per side, planar to slightly revolute, apex acute to obtuse. Inflorescences axillary, 6–8.5 mm, 1-flowered; bracts absent. Pedicel 2–4 mm, glabrous; bracteoles 2, apical, broadly ovate, not keeled, 1.2–2.5 × 1.2–1.5 mm, persistent, glabrous, margin entire, apex broadly obtuse. Calyx 3–3.5 mm; lobes 5, ovate-deltoid, 2.5–3 × 1.2–1.8 mm, not overlapping at base, glabrous, margin entire, apex acuminate. Corolla white, greenish white, pinkish white, white flushed with pink, or pink, urceolate, 3.5–4.5 × 2–3.5 mm, glabrous on both sides; lobes 5, oblong, 0.6–0.8 mm. Staminodes (in female flowers) 10, ca. 0.4 mm. Stamens 10; filaments ca. 1.2 mm, gradually dilated submedially from apex, glabrous; anthers 0.9–1.1 mm, 4-awned; awns 0.5–0.6 mm. Ovary glabrous; style 2.5–3 mm, glabrous. Calyx at fruiting white or pinkish white (in GLGS), fleshy; lobes incurved to erect, narrowly pale-edged. Capsule 4–7 mm in diam., glabrous.

We have not seen the material at W (H.F. v. Handel-Mazzetti's herbarium) for this treatment and thus we have not been able to lectotypify *Gaultheria cardiosepala*. Because the syntype at A of H.F. v. Handel-Mazzetti 9441 (and presumably all material of the 9441 collection) is *G. thymifolia*, a future lectotypification should be selected only among the material of H.F. v. Handel-Mazzetti 6416.

The collection T.T. Yü 20324, with white fruit, is atypical for *Gaultheria cardiosepala* in its setulose pubescence on the midvein abaxially, and may represent a hybrid with, e.g., *G. hypochlorea*. The collections GLGS 22409 and 23018, both sterile, also have this pubescence, but without reproductive features present it is difficult to confidently provide a species name for these specimens.

SELECTED ILLUSTRATION.—T.Z. Xu, Fl. Yunnan. 4:600 t. 171(4–8). 1986.

PHOTOGRAPHIC IMAGE.—Figure 3.

PHENOLOGY.—Fl. Mar–Jun, fr. Aug–Sep.

DISTRIBUTION AND HABITAT.—Subtropical evergreen broadleaf forests, coniferous forests, thickets, rocky places; 2100–4000 m. In GLGS: CHINA. Yunnan: Fugong Xian, Gongshan Xian (Cikai Zheng, Dulongjiang Xiang), Lushui Xian (Luyobenzhou Xiang, Pianma Xiang), Tengchong Xian (Houqiao Zheng), MYANMAR. Kachin: Myitkyina District (Chipwi Township); Figure 4. Outside of GLGS: Yunnan.

CHINESE NAME.—苍山白珠 cang shan bai zhu

ADDITIONAL GAOLIGONG SHAN SPECIMENS EXAMINED: CHINA, YUNNAN: F 30879 (E).



FIGURE 3. Fruiting plants of *Gaultheria cardiosepala*. Photo by L. Lu.

FUGONG XIAN. Che-tse-lo, 4000 m, 26 Aug 1934, *Tsai* 58197 (A, E). **GONGSHAN XIAN.** **Cikai Zheng.** E side of Gaoligong Shan at Km 48 on rd from Gongshan to Kongdang, 3330 m, 11 Nov 2004, *GLGS* 22409 (CAS); same data, *GLGS* 23108 (CAS). **Dulongjiang Xiang.** Salween-Kiu Chiang divide, Lunguailaka, 3200 m, 16 Sep 1938, *Yü* 20324 (A, E, KUN). **LUSHUI XIAN.** **Luyobenzhou Xiang.** E'ga Cun, Km 25 on forest rd, E side of Gaoligong Shan, 2130 m, 8 Aug 2005, *GLGS* 25749 (CAS). **Pianma Xiang.** W slope of Pianma Yakou, Fengxue Yakou, 3000 m, 27 Jul 1978, *BE* 1351 (KUN); Hpimaw Hill, 10800 ft., 10 May 1919, *R.J. Farrer* 895 (E); vicinity of Km 58 on rd from Lushui to Pianma, W side of Gaoligong Shan, 2810 m, 14 May 2005, *GLGS* 22922 (CAS); Pianma Yakou, 3300 m, 8 Jun 2006, *Lu* 22 (CAS); 3150 m, 4 Aug 1978, *NE* 1853 (KUN); Hpimaw, 10000–11000 ft., 20 Jun 1914, *KW* 1691 (E); Hpimaw Pass, 11000 ft., 8 Jun 1929, *Sukoe* 10080 (K); Pianma Yakou, Jia Gao Di, 3600 m, 15 Aug 1964, *Wu* 8416 (KUN). **TENGCHONG XIAN.** Shweli-Salween divide, 8000 ft., Mar 1906, *F* 5003 (A, E); W flank of Shweli-Salwin divide, 10000 ft., Aug 1912, *F* 8931 (A, E, K); Shweli-Salwin divide, 10000 ft., Sep 1913, *F* 12021 (E). **Houqiao Zheng (Guyong Zheng).** Ji Zhao Shan, 2640–3500 m, 25 May 1964, *Wu* 6886 (KUN); Dan Za to Liang Ya Shan, 3700 m, 18 Apr 1980, *L.S. Xie* 886 (KUN). **MYANMAR. KACHIN: MYITKYINA DISTRICT.** Chipwi Township. N'Maikha-Salwin divide, Jun 1931, *F* 29668 (E).

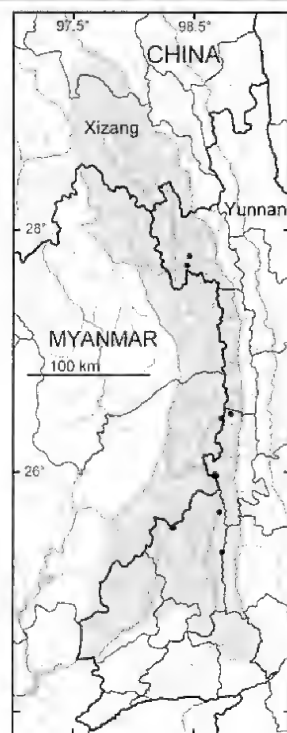


FIGURE 4. Distribution map of *Gaultheria cardiosepala* in the GLGS region.

3. *Gaultheria cuneata* (Rehder & E.H. Wilson) Bean, Bot. Mag. 145: t. 8829. 1919. Basionym: *Gaultheria pyroloides* J.D. Hooker & Thomson ex Miquel var. *cuneata* Rehder & E.H. Wilson in Sargent, Pl. Wilson. 1:554. 1913. TYPE.—CHINA. Sichuan: west and near Wen-chuan Xian, 2000–2600 m, July and September 1908, *E.H. Wilson* 920 (holotype: A!; isotypes: E!, GH!, K [2]!).

Shrublets 8–20 cm tall, prostrate to decumbent. Branchlets not notably elongate, terete, white-puberulent and usually sparsely orange- to brown-appressed-stipitate-glandular. Petiole 0.5–2 mm, puberulent and often also stipitate-glandular; leaf blade elliptic to slightly oblanceolate, 1.9–3.5 × 0.7–1.2 cm, 1.4–3.0 × as long as wide, chartaceous to subcoriaceous, abaxially greenish brown, abaxially and usually adaxially orange- to brown-appressed-stipitate-glandular, adaxially white-puberulent proximally on midvein, midvein abaxially raised and adaxially impressed, secondary veins 2–4 on each side of midvein, arising along midvein with proximal veins becoming faint or anastomosing before reaching apex, abaxially raised, adaxially planar to impressed, tertiary veins abaxially raised or obscure and adaxially impressed or obscure, base cuneate, margin shallowly serrate, with 8–20 teeth per side, planar to slightly revolute, apex acute to obtuse. Inflorescences terminal or subterminal (or both) open racemes, 0.8–4.5 cm, 2–10-flowered; rachis slender, white-puberulent, often also shortly stipitate-glandular; bracts ovate, not keeled, 2–3 × 1.2–2.5 mm, persistent, glabrous, margin entire or ciliolate, apex acute to obtuse. Pedicel 3–5 mm, shorter distally on inflorescences, orange-stipitate-glandular, glands more abundant and stipes longer distally on inflorescences; bracteoles medial to subapical, ovate to ovate-lanceolate, 2–3 × 1–2 mm, apex acute, otherwise similar to bracts. Calyx 1.5–2.5 mm; lobes 5, ovate, 1.5–2 × 1.2–1.7 mm, glabrous, margin entire or ciliolate, apex acute to acuminate. Corolla white to pink, urceolate, 4–5 × 2.5–5 mm, glabrous; lobes 5, deltoid, 0.7–1 mm. Stamens 10; filaments ca. 2 mm, gradually dilated submedially from apex, glabrous; anthers ca. 1 mm, awns ca. 1 mm. Ovary sericeous; style 2.5–4 mm, glabrous. Calyx at fruiting white to red, fleshy; lobes incurved, indistinctly pale-edged. Capsule 4–6 mm in diam., sericeous.

Gaultheria prostrata W.W. Smith [Notes Roy. Bot. Gard. Edinburgh 11:210. 1920. TYPE.—CHINA. Yunnan: Gongshan Xian, Mekong-Salween divide, 28°12'N, 14000 ft., July 1917, *G. Forrest* 14371 (holotype: E!; isotypes: K!, P!); = *Gaultheria pyroloides* Miquel var. *reducta* Diels, Acta Horti Gothob. 1:182. 1924. TYPE.—CHINA. Sichuan; mountains SE of Matang, 4800 m, 13 September 1922, *H. Smith* 4374 (holotype: ?B, destroyed; isotype: E!)], very similar to *G. cuneata*, may be expected to occur in the GLGS. It can be distinguished from *G. cuneata* by the generally smaller and rounder leaves (10–15 × 6–8 mm, 1.1–2 × as long as wide), bracts that are 2–3 mm wide, campanulate flowers with lobes ca. 1.5–2 mm, 2–4-awned anthers, and a style that is 1.5–2 mm. It also occurs at higher elevation (4250–4800 m) than *G. cuneata*.

SELECTED ILLUSTRATIONS.—Bean, Bot. Mag. 145: t. 8829. 1919; R.C. Fang, Fl. Reipubl. Popularis Sin. 57(3):48 t. 15(6–9). 1991; G.H. Zhu & L.B. Zhang, eds. Fl. China III. 14: t. 655(6–9). 2006.

PHENOLOGY.—Fl. Jul, fr. Aug–Oct.

DISTRIBUTION AND HABITAT.—*Rhododendron* forests, margins of *Abies* forests, thickets, on rocks; 3000–3800 m. In GLGS: CHINA. Xizang: Zayü Xian (Tsarong Xiang). Yunnan: Gongshan Xian (Bingzhongluo Xiang); Figure 5. Outside of GLGS: Guizhou, Sichuan, Yunnan.

CHINESE NAME.—四川白珠 si chuan bai zhu

GAOLIGONG SHAN SPECIMENS EXAMINED: CHINA. XIZANG: ZAYÜ XIAN. Tsarong Xiang.

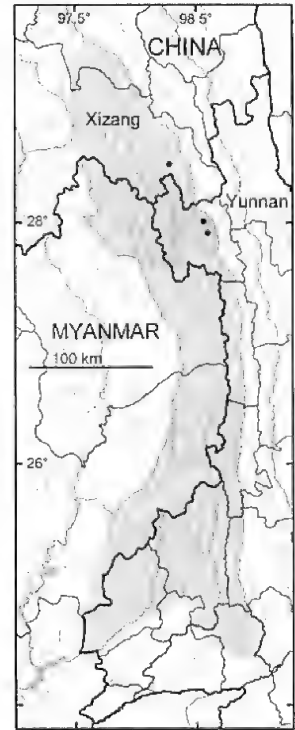


FIGURE 5. Distribution map of *Gaultheria cuneata* in the GLGS region.

Solo-la, 14500 ft., Aug 1932, *Rock* 22653 (A, K). YUNNAN: Atuntze, Hungpoh, Bengah, 3700 m, 19 Nov 1937, *Yü* 7998 (E); 1937, *Yü* 8917 (A); *Yü* 10192 (A). GONGSHAN XIAN. Bingzhongluo Xiang, Song Ta, 3800 m, 25 Jun 1982, *QX* 7547 (KUN); Cham-pu-tung, 3000 m, Sep 1935, *Wang* 66695 (A, KUN).

4. *Gaultheria discolor* Nuttall ex J.D. Hooker, Bot. Mag. 84: t. 5034. 1858. *Diplycosia discolor* (Nuttall ex J.D. Hooker) C.B. Clarke, Fl. Brit. India 3:459. 1882. TYPE.— Bot. Mag. 84: t. 5034. 1858; specimens, if such exist, not seen.

Gaultheria longibracteolata R.C. Fang, Novon 9:166.1999. TYPE.— CHINA. Yunnan: Luchun Xian, 1700 m, 19 September 1973, *D.D. Tao* 68 (holotype: KUN!; isotype: KUN!).

Shrubs 0.7–2.4 m tall, erect. Branchlets not notably elongate, angulate, densely ferrugineous-to brown-appressed- to ascending-setose and white-puberulent. Petiole 2–7 mm, setose and puberulent; leaf blade elliptic, 2.9–8.2 × 1.6–3.5 mm, apically along stems often smaller and narrower, 1.5–2.9 × as long as wide, subcoriaceous, abaxially light to dark brown (whitish green when fresh), with darker major veins, orange- to ferrugineous-gland-dotted or appressed-setulose with trichomes of various lengths, adaxially glabrous or proximally white-puberulent on midvein, midvein abaxially prominent and adaxially narrowly sulcate, secondary veins 2–4 on each side of midvein, arising at or near base and along midvein and extending to apex or nearly so, abaxially raised, adaxially slightly impressed to rarely planar, tertiary veins abaxially raised and adaxially impressed or obscure, base cuneate to subrounded, margin revolute at least proximally, basal half entire, apical half serrulate to denticulate with 10–25 teeth per side, apex acute, obtuse, or rarely shortly acuminate. Inflorescences axillary and terminal, dense racemes or occasionally panicles branched at or near base, 1.2–4 cm, 4–12-flowered; rachis slender, white- to yellow-hirsute or -lanate; bracts suborbicular to orbicular, keeled, 3.5–5.5 × 3–6 mm, caducous, glabrous or adaxially strigose medially, margin ciliate and often glandular-ciliate, apex shortly aristate. Pedicel 2.5–3.5 mm, white- to yellow-hirsute or -lanate; bracteoles apical, ovate-lanceolate, oblong-ovate, or oblong-elliptic, 3–6 × 1.5–3.2 mm, otherwise similar to bracts. Calyx 2.5–4 mm; lobes 5, ovate to ovate-deltoid, 2–3 × 1.5–2 mm, outside glabrous, inside strigose or hirtellous medially, apically keeled, margin ciliate or glandular-ciliate, apex acuminate-aristate. Corolla white, often with purple or pink lobes, urceolate, 4–5 × 3–5 mm, outside glabrous, inside white-villous; lobes 5, oblong, 0.7–1 mm. Stamens 10; filaments 1–1.5 mm, gradually dilated medially from apex, sparsely pilose; anthers 1–1.3 mm, awns 0.2–0.4 mm. Ovary hirtellous; style 2–3 mm, strigose at least proximally or rarely glabrous. Calyx at fruiting purple to black, fleshy, glaucous; lobes erect, not pale-edged. Capsule 3–7 mm in diam., sericeous-hirtellous.

In the original publication of *Gaultheria longibracteolata*, Fang (1999) distinguished this species from *G. discolor* by its densely hispid and puberulent branchlets, abaxially sparsely appressed-setulose leaf blades, pilose styles, and anthers with aristae ca. 0.8 mm. The description of *G. discolor* in the Flora of Bhutan (Rac 1991), however, stated that the branchlets there are sparsely setose (= hispid). Furthermore, our examination of specimens from outside the GLGS [i.e., *A. Henry* 9460B (A), 9460C (K), 9761 (A), 9761A (K); 1898, *F. Kingdon Ward* 7376 (K), 9091 (A); *S. Mokim* s.n. (E); May 1868, *C.S.P. Parish* s.n. (K); *Z.H. Tsi* 91-214 (A); *H.T. Tsai* 51543 (A); *C.W. Wang* 81223A (A); and *T.T. Yü* 17726 (A)] reveals that the other characters used to delimit the two species do not exhibit correlated gaps in morphological variation. Thus the delimitation of two species is not warranted.

SELECTED ILLUSTRATIONS.— J.D. Hooker, Bot. Mag. 84: t. 5034. 1858; R.C. Fang, Novon 9:168 t. 4. 1999 (as *G. longibracteolata*); G.H. Zhu & L.B. Zhang, eds. Fl. China Ill. 14: t. 659(1–7). 2006 (as *G. longibracteolata*).



FIGURE 6. Flowering branchlet of *Gaultheria discolor*. Photo by P. Fritsch.

PHOTOGRAPHIC IMAGE.— Figure 6.

PHENOLOGY.— Fl. May–Sep fr. Sep–Jan.

DISTRIBUTION AND HABITAT.— Subtropical evergreen broadleaf forests, thickets, open slopes; 900–2000 m. In GLGS: CHINA. Yunnan: Gongsan Xian (Dulongjiang Xiang); Figure 7. Outside of GLGS: Yunnan [Myanmar, Thailand].

CHINESE NAME.— 苍白叶白珠 (新拟) an bai ye bai zhu

GAOLIGONG SHAN SPECIMENS: CHINA. YUNNAN: GONGSHAN XIAN, Dulongjiang Xiang. Along trail toward Qinglan Dang, W side of the Dulongjiang Valley, ca. 0.3 direct km SW of Maku and ca. 4.2 direct km NE of Myanmar border, 2010 m, 19 Aug 2006, GLGS 32542 (KUN).

5. *Gaultheria dolichopoda* Airy Shaw, Bull. Misc. Inform. Kew 1940:321. 1941. TYPE.— CHINA. Xizang: Tsangpo Gorge, near Sechen La, 3000–3300 m, 1 December 1924, *F. Kingdon Ward 6331* (holotype: K!).

Shrublets 5–23 cm tall, decumbent. Branchlets elongate, terete, densely ferrugineous-uncinate-setulose. Petiole 0.7–1.5 mm, glabrous or adaxially occasionally white-puberulent; leaf blade linear-oblancoate, 6–9.5(–15) × 1.5–1.8(–4) mm, usually gradually smaller along stems toward both ends of each year's growth, 3.3–4.8 × as long as wide, coriaceous, abaxially dull light green to light brown with glossy edge, adaxially glossy green to brown, both surfaces glabrous or adaxially occasionally puberulent toward base on midvein, midvein abaxially prominent and adaxially sulcate, secondary and tertiary veins obscure, base cuneate, margin serrate, with 5–7 setulose-tipped teeth per side, planar to slightly revolute, apex acute to obtuse. Inflorescences axillary, 1.5–2 cm, 1-flowered; bracts absent. Pedicel slender, drooping, 0.9–1.3 cm,

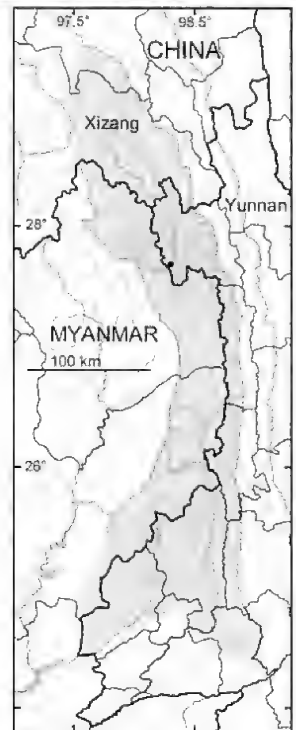


FIGURE 7. Distribution map of *Gaultheria discolor* in the GLGS region.

glabrous; bracteoles 2, apical, ovate-deltoid, not keeled, $0.5-1(-1.2) \times 0.5-0.7(-1.4)$ mm, persistent, glabrous, margin entire, apex acute to shortly acuminate. Calyx 3–4 mm; lobes 5, ovate-deltoid, $2-3 \times 1.5-1.7$ mm, not overlapping at base, glabrous, margin entire, apex acuminate. Corolla white to pink, broadly urceolate, ca. 5×4 mm, both sides glabrous; lobes 5, oblong, ca. 0.5 mm. Stamens ca. 2 mm, dilated near base from apex; anthers 4-awned. Ovary glabrous; style ca. 3 mm, glabrous. Calyx at fruiting blue, fleshy; lobes incurved, not pale-edged. Capsule ca. 5 mm in diam., glabrous.

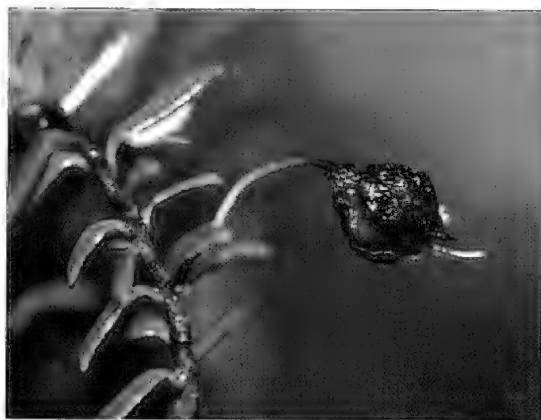


FIGURE 8. Fruiting branchlet of *Gaultheria dolichopoda*. Photo by L. Lu.

The type of *Gaultheria dolichopoda* has notably larger leaves than our specimens of the species.

SELECTED ILLUSTRATION.—Airy Shaw, Kew Bull. 1948:161 t. 4, 1948. The illustration of this species in T.Z. Xu, Fl. Xizang, 3:694 t. 277(1) has a pedicel that is too short for *Gaultheria dolichopoda* and is likely based on a specimen of a different species of *Gaultheria*, e.g., *G. hypochlora*.

PHOTOGRAPHIC IMAGE.—Figure 8.

PHENOLOGY.—Fl. Aug, fr. Oct.

DISTRIBUTION AND HABITAT.—Alpine thicket-meadows, *Abies* forests, rocky places, thickets; 2700–3000 m. In GLGS: CHINA. Yunnan: Gongshan Xian (Dulongjiang Xiang), MYANMAR. Kachin: Putao District (Nogmung Township); Figure 9. Outside of GLGS: Xizang.

CHINESE NAME.—长梗白珠 chang geng bai zhu

GAOLIGONG SHAN SPECIMENS EXAMINED: CHINA. YUNNAN: GONGSHAN XIAN. Dulongjiang Xiang. Vicinity of Xixiaofang on trail from Bapo to Gongshan via Qiqi, W side of Gaoligong Shan, 2970 m, 30 Oct 2004, GLGS 22005 (CAS); Xi Shao Fang, W side of GLGS, 2700–2900 m, 4 Jun 2006, Lu 58A (CAS). MYANMAR. KACHIN: PUTAO DISTRICT. Nogmung Township. Mungku Hkyet, 9000–10000 ft., 19 Aug 1937, KW 13005 (BM).

6. *Gaultheria dumicola* W.W. Smith, Notes Roy. Bot. Gard. Edinburgh 9:106. 1916. TYPE.—CHINA. Yunnan: [Tengchong Xian], hills west of Tengyueh [Gaoligong Shan], 25°N , 6000 ft., July 1912, *G. Forrest* 8573 (lectotype, here designated: E! isolectotypes: A!, K!).

Three collections of *G. Forrest* (7730, 8573, and 9568) were cited in the protologue, none of which were specifically designated as the type of *Gaultheria dumicola*. We have selected *G. Forrest* 8573 from E as lectotype because it is the home institution of W.W. Smith and the word “Type” is handwritten on the E sheet along with a label on which is printed “Type Specimen.” We do not know if the handwriting is Smith’s.

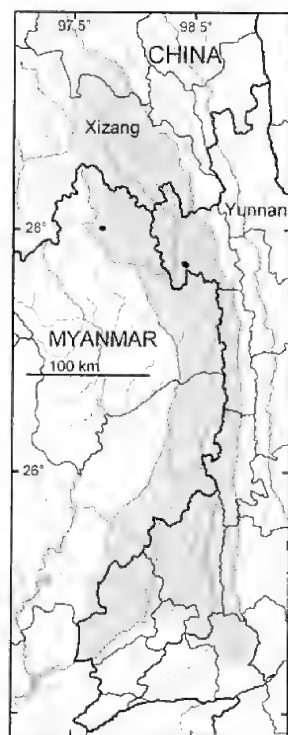


FIGURE 9. Distribution map of *Gaultheria dolichopoda* in the GLGS region.

- Gaultheria dumicola* W.W. Smith var. *petanoneuron* Airy Shaw, Hooker's Icon. Pl. 33: t. 3206. 1933. TYPE.— CHINA. Yunnan: [Tengchong Xian], N'maikha-Salwin divide [Gaoligong Shan], 26°N, 8000–9000 ft., November 1919, G. Forrest 18832 (holotype: K!; isotype: E!).
- Gaultheria dumicola* W.W. Smith var. *aspera* Airy Shaw, Bull. Misc. Inform. Kew 1940:312. 1941. TYPE.— MYANMAR. Kachin: [Putao District, Nogmung Township], Adung Valley [Gaoligong Shan], 1800 m, 17 February 1931, F. Kingdon Ward 9245 [as "9425" in protologue] (holotype: BM; isotype: A!).
- Diplycosia pauciseta* Merrill, Brittonia 4:153. 1941. TYPE.— MYANMAR. Kachin: [Putao District, Nogmung Township], Adung Valley [Gaoligong Shan], 1800 m, 17 February 1931, F. Kingdon Ward 9245 [as "9425" in protologue] (holotype: A!).
- Diplycosia alboglaucula* Merrill, Brittonia 4:153. 1941. TYPE.— MYANMAR. [Kachin: Myitkyina District, Chip-wi Township], Kang-fang [Gaoligong Shan], 1600 m, 6 December 1938, Vernay-Cutting Expedition (F. Kingdon Ward) 84 (holotype: NY [on-line image!]).
- Gaultheria dumicola* W.W. Smith var. *pubipes* Airy Shaw, Kew Bull. 1948:110. 1948. TYPE.— CHINA. Yunnan: [Fugong Xian, Shangpa Zheng], Shang-pa Hsien [sic][Gaoligong Shan], 2400 m, 13 October 1933, H.T. Tsai 54404 (holotype: A!).

Shrubs 0.6–4 m tall, erect, gynodioecious. Branchlets elongate, terete to slightly flattened, (in GLGS) glabrous or often sporadically white-puberulent. Petiole 2–7 mm, glabrous, puberulent, gland-dotted, or setose; leaf blade ovate to ovate-lanceolate, 5–16 × 2.5–9.7 cm, apical blades along stems generally smaller and narrower than basal ones, 1.3–4.1 × as long as wide, subcoriaceous, abaxially greenish brown to brown and glabrous or dark red-gland-dotted, -setose, or -vil-lous, adaxially glabrous, veins abaxially prominent, midvein adaxially sulcate, secondary vein 1(2) on each side of midvein, arising at or near base and extending to apex, inner tertiary veins 7–13 on each side of midvein and adaxially slightly impressed, base subrounded, rounded, or cordate (basally on branchlets blade base often rounder or more strongly cordate than those apically on branchlets), margin irregularly denticulate, with many often setose-tipped teeth, planar to slightly revolute, apex acuminate to caudate. Inflorescences axillary and terminal, dense racemes or glomerules, 0.9–2.3 cm, 2–23-flowered; rachis stout, glabrous or white-puberulent; bracts narrowly deltoid, keeled, 1.3–2.3 × 0.6–1 mm, persistent, glabrous, margin ciliolate or glandular-ciliolate, apex acute. Pedicel 3–10 mm, glabrous or white-puberulent; bracteoles basal, similar to bracts. Calyx 2.2–2.6 mm; lobes 5, ovate to lanceolate-deltoid, 1.7–2.5 × 0.7–1.3 mm, glabrous, margin entire, apex acuminate. Corolla green, greenish yellow, greenish white, or green distally flushed with red and dark red, campanulate, 3–4 × 2.5–4.5 mm, glabrous; lobes 5, broadly deltoid, ca. 1 mm. Stamines (in female flowers) ca. 0.7 mm. Stamens 10; filaments 0.7–1 mm, gradually dilated medially from apex, glabrous or sparsely hirtellous; anthers ca. 1 mm, awns ca. 0.4 mm. Ovary sparsely strigillose-hirtellous; style 1–2 mm, glabrous. Calyx at fruiting dark purple to black, thin, often glaucous; lobes incurved, not pale-edged. Capsule 3–6 mm in diam., sparsely strigillose-hirtellous.

Five varieties of *Gaultheria dumicola* have been recognized in the treatment of *Gaultheria* for Flora of China (Fang and Stevens 2005), four of which (i.e., all except var. *hirticaulis* R.C. Fang) have morphological features that are represented in the GLGS. Varieties *dumicola* and *petanoneu-ron* have glabrous twigs, leaves, and inflorescences, and are distinguished from each other by broadly ovate leaf blades that are usually cordate or rounded-truncate at the base in var. *petanoneu-ron*, versus ovate leaf blades that are cuneate to rounded at the base in var. *dumicola*. Variety *pubipes* has puberulent young twigs, pedicels, bracts, and bracteoles and glabrous leaf blades, whereas var. *aspera* has glabrous young twigs, pedicels, bracts, and bracteoles and shortly brown-hispid leaf blades abaxially.

From thorough examination of these characters as they occur in the GLGS and surrounding

areas, we conclude that the pattern of morphological variation present in the specimens representing these four varieties does not justify the recognition of infraspecific taxa. White puberulence on the vegetative parts and pedicels, like most species of *Gaultheria* in the GLGS, is sporadic and can occur independently of the other features used to diagnose varieties—when observed under high magnification, it can be seen that even the type of *G. dunicola* has such stem pubescence. Most of the variation in leaf blade shape occurs within, rather than among, plants: leaf blades are typically larger and more cordate proximally along the stem, and gradually become smaller and more rounded at the base distally. Usually when a specimen has been annotated as var. *petanoneuron*, the stem segments of such specimens have been taken from the proximal part of a branchlet. There does appear to be a weak south-to-north trend within the GLGS populations of *G. dunicola* of narrower leaf blades that are less cordate at the base, but these characters vary continuously. Finally, on much of the Chinese side of the border, there does appear to be a strong break in variation between around 26 and 27 degrees latitude (Fugong County) in plants with glabrous leaf blades to the south versus those with setose-villous leaf blades abaxially to the north. Nonetheless, this distinction breaks down in various regions: in the Pianma area, there are plants with glandular dots but no trichomes; in the north part of the GLGS (Dulongjiang Xiang), several collections have no glands or trichomes; and all the collections from Myanmar, whether in the northern or southern part of the range of the species, have both glands and trichomes, or sometimes the glands are tipped with short trichomes.

SELECTED ILLUSTRATIONS.—Airy Shaw, Hooker's Icon. Pl. 33: t. 3206. 1933 (as *G. dunicola* var. *petanoneuron*); T.Z. Xu, Fl. Xizang. 3:696 t. 278(8–10). 1986.

PHOTOGRAPHIC IMAGES.—Figures 10–11.

PHENOLOGY.—Fl. Jan–Dec, fr. May–Dec.

DISTRIBUTION AND HABITAT.—Subtropical evergreen broadleaf forests, mixed evergreen and deciduous broadleaf forests, coniferous forests, thickets, open slopes; 1400–3100 m. In GLGS: CHINA. Yunnan: Fugong Xian (Lishadi Xiang, Shangpa Zheng), Gongshan Xian (Dulongjiang Xiang), Lianghe Xian, Longling Xian (Longjiang Xiang, Zhen'an Zheng), Longyang Qu (Bawan Xiang, Lujiang Xiang, Mankuan Xiang), Lushui Xian (Luobenzhou Xiang, Pianma Xiang), Tengchong Xian (Houqiao Zheng, Jietou Xiang, Qushi Xiang, Ruidian Xiang, Shangyun Xiang, Yunhua Xiang, Zhonghe Xiang), MYANMAR. Kachin: Myitkyina District (Chipwi Township,

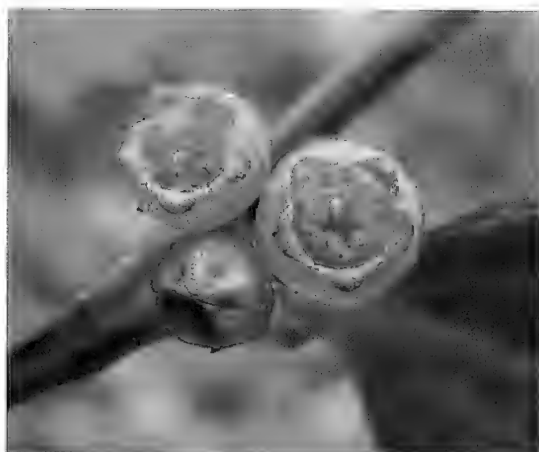


FIGURE 10. Hermaphroditic inflorescence of *Gaultheria dunicola*. Photo by P. Fritsch.



FIGURE 11. Female inflorescence of *Gaultheria dunicola*. Note staminodes against sides of ovary in flower on right. Photo by P. Fritsch.

Hsawlaw Township), Putao District (Nogmung Township); Figure 12. Outside of GLGS: Yunnan [Myanmar].

CHINESE NAME.— 丛林白珠 *cong lin bai zhu*

ADDITIONAL GAOLIGONG SHAN SPECIMENS EXAMINED: CHINA.

YUNNAN: Jul 1912, *F 15785* (A, E [2], K [2]); Mid W Yunnan, Dec 1924, *F 26075* (E, K). **FUGONG XIAN.** Bi Jiang Agriculture Middle School, 2500 m, 27 May 1978, *BE 86* (KUN); Che-tse-lo, 3200 m, 12 Sep 1934, *Tsai 58538* (A, KUN); Kong Dong La Bu Jin, 2500 m, 7 Jul 1978, *NE 908* (KUN); **Lishadi Xiang.** Vicinity of N fork of the Yamu River, ca. 0.7 km E of Shibali Logging Station, on rd from the Nuijiang to Yaping Pass, E side of Gaoligong Shan, 2467 m, 2 May 2004, *GLGS 20245* (CAS); Yaduo Cun, vicinity of Shibali, N side of N fork of the Yamu He, E side of Gaoligong Shan, 2590 m, 4 Aug 2005, *GLGS 26349* (CAS); Niwaluo Cun, vicinity of Shiwanluo Village above the Nuijiang, E side of Gaoligong Shan, 1500 m, 12 Aug 2005, *GLGS 27387* (CAS). **Shangpa Zheng.** Zhuminglin Cun, ca. 2 km E of the Nuijiang above Zhuminglin Village, E side of Gaoligong Shan, 1940 m, 22 Aug 2005, *GLGS 28845* (CAS); 1600 m, 2 Oct 1933, *Tsai 54726* (A, E, KUN); 1600 m, 5 Oct 1933, *Tsai 54770* (A, E, KUN); 1800 m, 8 Oct 1934, *Tsai 54817* (A, E, KUN); 2000 m, 20 Sep 1933, *Tsai 56533* (A, KUN); 2100 m, 27 Sep 1933, *Tsai 56641* (A, E); 2800 m, 10 Oct 1934, *Tsai 58671* (A, KUN); 2000 m, 29 Oct 1934, *Tsai 59061* (A, E); 2000 m, 31 Oct 1934, *Tsai 59162* (A). **GONGSHAN XIAN.** **Dulongjiang Xiang.** Ma Gu, 2000 m, 17 Nov 1959, *Feng 24318* (KUN [2]); vicinity of Maku, S region of the Dulongjiang Valley, W side of the Dulongjiang, 2080 m, 16 Dec 1990, *GLGS 1101* (CAS, KUN); vicinity of Moqiewang, middle region of the Dulongjiang, ca. 4 km NNE of Kongdang, E side of the Dulongjiang, 2200 m, 14 Jan 1991, *GLGS 1881* (CAS, KUN); Dan Dang He, 2000 m, 18 Jan 1991, *GLGS 3267* (KUN); along the Dandangwang He, NW of Bapo, W side of the Dulongjiang, 1800 m, 18 Jan 1991, *GLGS 3268* (CAS, KUN); Dan Dang He, 1400 m, 19 Jan 1991, *GLGS 3300* (KUN); Li Qi, 1850 m, 28 Jan 1991, *GLGS 3710* (KUN); Maku, 2100 m, 13 Mar 1991, *GLGS 4550* (KUN); same data, *GLGS 4562* (KUN); Xue Ba La Ka, 2000 m, 20 Apr 1991, *GLGS 6175* (KUN); N of the second team, 2300 m, 16 May 1991, *GLGS 6846* (KUN); S of the second team, 1400 m, 19 Jan 1991, *GLGS 6907* (KUN); above Panjiasheng between Shigong Qiao and Xixiaofang on trail from Bapo to Gongshan via Qiqi, W side of Gaoligong Shan, 2350 m, 31 Oct 2004, *GLGS 22027* (CAS [2]); W side of the Dulongjiang Valley, ca. 1 direct km NW of Maku and ca. 4.5 direct km NE of Myanmar border, 2140 m, 18 Aug 2006, *GLGS 32478* (CAS); San Dui, 2000 m, 5 Jun 2006, *Lu 66* (CAS); Maku, 2200 m, 6 Aug 1982, *QX 8939* (KUN); Long Yuan, 2400 m, 26 Aug 1982, *QX 9664* (KUN); Long Yuan, 2500 m, 30 Aug 1982, *QX 9751* (KUN); Taron-Taru divide, bucahwang, 1700 m, 29 Oct 1938, *Yü 20873* (A, E, KUN); Tangtewang, 2300 m, 7 Nov 1938, *Yü 20999* (E, KUN). **LIANGHE XIAN.** From Mangdong to Mongyang, 1450 m, 17 Oct 1974, *G.D. Tao 12813* (KUN). **LOGLING XIAN.** **Longjiang Xiang.** Da Mo Shan, 1830–2340 m, 4 Dec 1958, *J. Chen 720* (KUN); ridge S of pass at top of Gaoligong Shan on old rd from Baoshan to Tengchong via Dahooping, E side of Gaoligong Shan, 2410 m, 5 Sep 2003, *GLGS 18831* (CAS); 2500 m, 18 Aug 1941, *Wang 90126* (KUN). **Zhen'an Zheng.** Vicinity of Nankang Village, E side of Gaoligong Shan, ca. 3 km E of pass on new rd from Baoshan to Tengchong via Nankang Yakou, 1908 m, 25 Aug 2003, *GLGS 17831* [mistakenly as Longyang Qu, Lujiang Xiang on the label but all other data are correct] (CAS). **LONGYANG QU.** **Bawan Xiang.** Vicinity of Nankang Yakou, E side of Gaoligong Shan near crest, 2170 m, 26 May 2005, *GLGS 23757* (CAS). **Lujiang Xiang.** Nankang Botanic Garden (Lihuipo), summit of Gaoligong Shan, 2130 m, 18 Nov 2000, *GLGS 13197* (CAS, KUN); Lihuipo area near Nankang Village, E side of Gaoligong Shan near crest, just N of new rd from Baoshan to Tengchong via Nankang Yakou, 2210 m, 24 Aug 2003, *GLGS 17711* (CAS). **Mangkuan Xiang.** Bai Hua Ling, 2400 m, 27 Jan 1995, *GLGS 61* (KUN [2]); Baihualing, Daluchang National Forest, E side of Gaoligong Shan, 2100 m, 25 Nov 2000, *GLGS 13428* (CAS, KUN); Baihualing Cun, Jiujiezi area, E side of Gaoligong Shan, 1985 m, 8 Sep 2003, *GLGS 18883* (CAS). **LUSHUI**

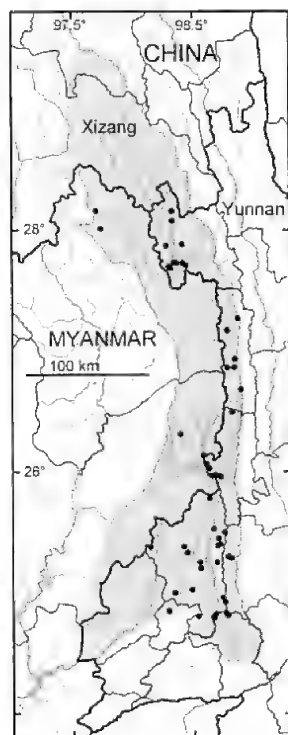


FIGURE 12. Distribution map of *Gaultheria dumicola* in the GLGS region.

XIAN. Yao Jia Ping, along rd to Lu Zhang, 2440 m, 25 Oct 1996, *GLGS 8013* (E, KUN); Yaojiaping, 2440 m, 25 Oct 1996, *GLGS 8063* (KUN); same location, 2270 m, 28 Oct 1996, *GLGS 8215* (E, KUN); Shangjiang District, 17 Apr 1960, *NW Yunnan Expedition 8232* (KUN); from Liushui to Yaojiaping, 2050 m, 2 Jul 1960, *NW Yunnan Expedition 10343* (KUN [2]); Close to Da He, Zhuan Wang He, 2400 m, 30 Jun 1964, *Wu 7316* (KUN). **Luobenzhuo Xiang.** Vicinity of Bifu Bridge, ca. 32.7 direct km S of Fugong City and ca. 7.7 direct km W of the Nujiang, E side of Gaoligong Shan, 2640 m, 1 May 2004, *GLGS 208334* [mistakenly recorded as Fugong Xian, Pihe Xiang on the label but all other data are correct] (CAS). **Pianma Xiang.** Gugang Community, from Pianma to Wu Zhong, 2200 m, 29 Jul 1978, *BE 1486* (KUN); 17 km N of Pianma toward Gangfang, W side of Gaoligong Shan, 2253 m, 17 May 2005, *GLGS 24382* (CAS); Pianma Yakou, 2100 m, 31 May 2006, *Lu 101* (CAS); same location, 2200 m, 31 May 2006, *Lu 102* (CAS); Pianma to Pianma Yakou, 2500 m, 14 Aug 1964, *Wu 8356* (KUN). **TENGCHONG XIAN.** Mid W of Yunnan, 7000 ft., Dec 1924, *F 7730* (E, K); Ma-chang-Kai Valley, N of Tengyueh, 6000–7000 ft., Feb 1913, *F 9568* (A, E, K); Shweli-Salwin divide, 9000–10000 ft., Jul 1918, *F 17774* (E, K); between Tengyueh and Burmese border, en route to Sadon, 8000 ft., Nov 1922, *Rock 7293* (A); same data, *Rock 7293a* (A); prope Tengyueh, 1800 m, Oct 1914, *C.K. Schneider 2561* (A, GH, K). **Houqiao Zheng (Guyong Zheng).** Vicinity of Gaoshidong in Guyong Linchang (forest farm), ca. 9.8 direct km ENE of Houqiao (Guyong), 2570 m, 27 May 2006, *GLGS 30676* (CAS). **Jietou Xiang.** Between Jietou and Datang, 1670 m, 27 Oct 1998, *GLGS 11078* (CAS, KUN); Shaba Cun, Tientai Shan, W side of Gaoligong Shan, 2240 m, 28 Oct 1998, *GLGS 11123* (CAS, KUN); Shaba Cun, community forest of Lidazhai, W side of Gaoligong Shan, 1880 m, 23 Dec 2000, *GLGS 13601* (CAS, KUN); Xinzhuang Cun, vicinity of Lijiapo, ca. 5.9 direct km ENE of Jietou on W side of Gaoligong Shan, 1940 m, 23 May 2006, *GLGS 29462* (CAS). **Qushi Xiang.** Jiang Zuo, 2030–2300 m, 14 Sep 1960, *Yin 60-1044* (KUN). **Ruidian Xiang.** Yunfeng Cun, Yunfeng Shan, along trail from Yunfeng Si to base of mtn. on N side of the moist valley directly E of Yunfeng Si, ca. 8.6 direct km SSW of Ruidian, 2010 m, 3 Jun 2006, *GLGS 31006* (CAS). **Shangyun Xiang.** W side of Gaoligong Shan on old trail (southern silk road) just N and above old rd from Baoshan to Tengchong via Dahooping, 2300 m, 4 Sep 2003, *GLGS 18687* (CAS). **Yunhua Xiang.** 2000 m, 13 Oct 1963, *J.Z. Zhao 7* (KUN). **Zhonghe Xiang.** Huan Xi Po, 2100 m, 8 Aug 1980, *S.H. Li 80-599* (KUN). **MYANMAR. KACHIN: MYITKYINA DISTRICT. Hsawlaw Township.** Chawngwaw, 7000 ft., *KW 3486* (E). **PUTAO DISTRICT. Nongmung Township.** Nam Tamai Valley, Mungku Hkyet, 7000–8000 ft., 1937, *KW 13489* (BM).

7. *Gaultheria eciliata* (S.J. Rae & D.G. Long) P.W. Fritsch & L.H. Zhou, **comb. & stat. nov.** Basionym: *Gaultheria trichophylla* Royle var. *eciliata* S.J. Rae & D.G. Long, Notes Roy. Bot. Gard. Edinburgh 45:334. 1988. TYPE.—BHUTAN, Mongar: Pung La, 3660 m, 9 July 1949, *F. Ludlow, G. Sherriff, & J.H. Hicks 20904* (holotype: BM, photo of holotype, E!).

Chiogenes suborbicularis W.W. Smith var. *albiflorus* T.Z. Xu, Acta Bot. Yunnan. 6:41. 1984. TYPE.—CHINA, Yunnan: Gongshan Xian, Mekong-Salwin divide, Sila, 4000 m, 16 August 1938, *T.T. Yü 22351* (holotype: KUN No. 0482916!; isotype: KUN No. 0482917!).

Shrublets, prostrate. Branchlets elongate, light brown flushed with red, terete, black-uncinate-setulose. Petiole 0.4–1 mm, glabrous; leaf blade elliptic, often asymmetric, 3.5–6.5 × 1–2.5 mm, gradually smaller along stems toward both ends of each year's growth, 1.5–4 × as long as wide, subcoriaceous, green, glabrous, both surfaces ± glossy, midvein abaxially planar and adaxially planar to slightly sulcate, secondary and tertiary veins obscure, base cuneate to rounded, margin serrate, with 3–8 setulose-tipped teeth per side, planar, apex slightly acuminate. Inflorescences 5–10 mm, 1-flowered; bracts absent. Pedicel 1–2 mm, glabrous; bracteoles 2, apical, orbicular, not keeled, 1.3–1.6 × 1.3–1.8 mm, persistent, glabrous, margin entire, apex broadly obtuse to rounded. Calyx 1.7–2.6 mm; lobes 5, ovate-deltoid, 1.3–1.8 × 1.4–2 mm, overlapping at base, outside glabrous, inside glabrous or pubescent, margin entire, slightly erose, or ciliolate, apex bluntly acute. Corolla white, campanulate, 3–4 × 2.7–4 mm, glabrous on both sides; lobes 5, deltoid-oblong, 0.7–1.1 mm. Stamens 10; filaments 1.1–1.4 mm, gradually or abruptly dilated subbasally

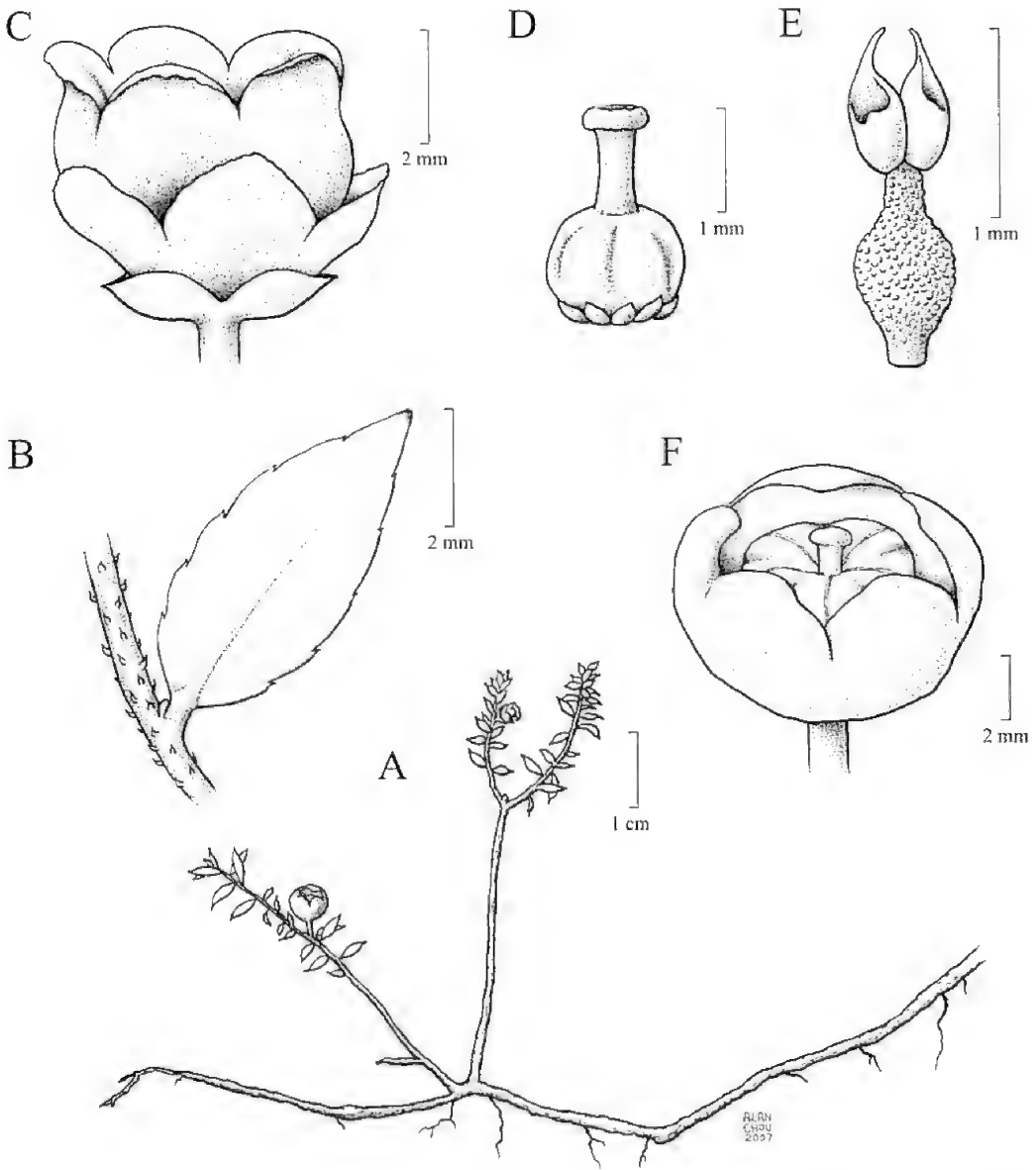


FIGURE 13. *Gaultheria eciliata*. - A. Whole plant, in fruit. - B. Branchlet and leaf (abaxial view). - C. Flower. - D. Gynoecium with subtending nectary disk. - E. Stamen. - F. Fruit. C-E based on Yü 19877 (E); A, B, F based on GLGS 16874 (CAS).

from apex, glabrous; anthers 0.5–0.7 mm, 2-awned; awns 0.1–0.3 mm. Ovary glabrous; style 0.9–1.1 mm, glabrous. Calyx at fruiting blue, fleshy; lobes incurved or erect, not pale-edged. Capsule 4–6 mm in diam., glabrous.

Rae and Long (in Long 1988) described this taxon as a variety of *Gaultheria trichophylla*, distinguishing it from the nominal variety by its smaller, ovate leaf blades with serrulate, eciliate margins and acute apex. We observed the following differences in var. *trichophylla* versus var. *eciliata*: leaf blade width 2–6 mm (versus 1–2.5 mm) with midvein abaxially raised to prominent (ver-

versus planar), marginal teeth setose-tipped (versus setulose-tipped), and apex acute to subrounded (versus slightly acuminate); calyx 2.8–3.6 mm (versus 1.7–2.6 mm) with lobes mostly not overlapping at base (versus overlapping at base); corolla lobes 1.8–2.8 mm (versus 0.7–1.1 mm); anthers 0.7–1 mm (versus 0.5–0.7 mm) with awns 0.3–0.9 mm (versus 0.1–0.3 mm); and style 2–2.5 mm (versus 0.9–1.1 mm). With the apparent absence of any intermediacy in these characters between the two taxa, we consider the differences between them substantial enough to warrant recognition of variety *eciliata* at the species level.

ILLUSTRATION.— Figure 13.

PHOTOGRAPHIC IMAGE.— Figure 14.

PHENOLOGY.— Fl. Jul–Aug, fr. Aug–Oct.

DISTRIBUTION AND HABITAT.— Montane grasslands, thickets, meadows; 3200–4100 m.

In GLGS: CHINA. Xizang: Zayü Xian. Yunnan: Gongshan Xian (Bingzhongluo Xiang, Cikai Zheng, Dulongjiang Xiang); Figure 15. Outside of GLGS: Yunnan [Bhutan].

CHINESE NAME.— 须毛白珠 (新拟) xu mao bai zhu.

GAOLIGONG SHAN SPECIMENS EXAMINED: CHINA. XIZANG: ZAYÜ XIAN. Ri Dong Qu, 4100 m, 9 Sep 1982, *QX 10228* (KUN). **YUNNAN: GONGSHAN XIAN. Bingzhongluo Xiang.** Chang Pu Tong, 3500–3700 m, 10 Jul 1940, *Feng 7675* p.p. (KUN); vicinity of Niwaidanbu, ca. 2.4 direct km SW of Gawagapu Mtn., ca. 1.3 direct km E of Chukuai Lake and ca. 16.5 direct km WSW of Bingzhongluo, W side of Gaoligong Shan, 3900 m, 30 Aug 2006, *GLGS 31667* (CAS). **Cikai Zheng.** N of rd from Gongshan to Kongdang, E side of Gaoligong Shan, u-shaped valley draining into upper reaches of the Pula He, 3429 m, 3 Oct 2002, *GLGS 16952* (KUN); Yipsaka Lake, 2.4 direct km SE of Heipu Pass tunnel on new rd from Gongshan to Dulongjiang Valley, E side of Gaoligong Shan, 3500 m, 12 Aug 2006, *GLGS 32019* (CAS); Heipu Pass along rd from Gongshan to Dulongjiang valley, E side of Gaoligong Shan, 3490 m, 12 Aug 2006, *GLGS 32041* (CAS); Yipsaka Lake, 2.4 direct km by SE of Heipu Pass tunnel on new rd from Gongshan to Dulongjiang Valley, E side of Gaoligong Shan, 3560 m, 12 Aug 2006, *GLGS 32078* (CAS); ca. 1.2 direct km SSE of Heipu Pass tunnel on new rd from Gongshan to Dulongjiang Valley, E side of Gaoligong Shan, 3350 m, 13 Aug 2006, *GLGS 32102* (CAS). **Dulongjiang Xiang.** N side of pass above tunnel on rd between Gongshan and Kongdang, W side of Gaoligong Shan, 3530 m, 2 Oct 2002, *GLGS 16874* (CAS); Upper Kiukiang Valley, S of Lungtsahmura, 3900 m, 10 Aug 1938, *Yü 19877* (A, E, KUN); Salween-Kiu Chiang divide, Lunguailaka, 3200 m, 16 Sep 1938, *Yü 20336* (A, E).

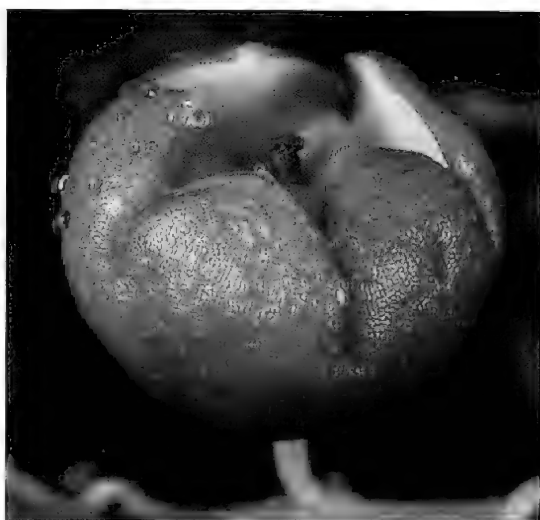


FIGURE 14. Fruiting branch of *Gaultheria eciliata*. Photo by D. Lin.

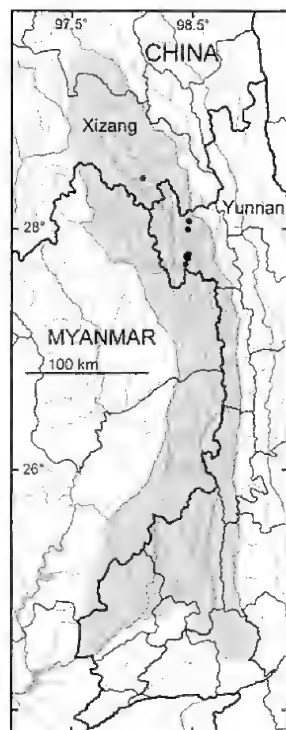


FIGURE 15. Distribution map of *Gaultheria eciliata* in the GLGS region.

8. *Gaultheria fragrantissima* Wallich, *Asiat. Res.* 13:397. 1820. TYPE.— Nepal. *N. Wallich* 765 (probable holotype: K; isotypes: A [image!], L [on-line image!], NY [2; on-line images!]).

Gaultheria forrestii Diels, Notes Roy. Bot. Gard Edinburgh 5:210. 1912. TYPE.—CHINA. Yunnan: east flank of the Tali Range, 25°40'N, 10000–12000 ft., July 1906, *G. Forrest* 4183 (lectotype, here designated: E!; isoelectotype: A!).

Although *N. Wallich*'s type material is mainly at K, we have not seen material of *N. Wallich* 765 from K and do not know if such exists. The disposition of the holotype, therefore, remains in question.

Diels cited two collections in the protologue of *Gaultheria forrestii* (*G. Forrest* 4175 and 4183), neither of which was specifically indicated as the type. We have designated the E specimen of *G. Forrest* 4183 as lectotype because it is the only sheet we have seen among the duplicates of the two collections with the word "Type" hand-written on it. The handwriting may be that of Diels, as based on the handwriting sample in Steenis (1950), although types of other species not named by Diels also sometimes have "Type" in the same handwriting.

Shrubs or rarely small trees, 0.25–4 m tall, erect, arching, or pendent, with strong wintergreen odor, gynodioecious. Branchlets elongate, slightly angulate, glabrous or occasionally patchily white-puberulent and/or sparsely red- to brown-appressed to -ascending-setulose. Petiole 0.5–1.5 cm, glabrous or occasionally puberulent or setulose or both; leaf blade elliptic, oblong-elliptic, or ovate-elliptic, 6.9–17 × 2.4–7.4 cm, those near inflorescences generally smaller, 1.7–4.1 × as long as wide, chartaceous to subcoriaceous, abaxially greenish brown to brown and dark red- to brown-gland-dotted or -setulose, adaxially white-puberulent proximally along midvein, midvein abaxially prominent and adaxially sulcate, secondary veins 3–6 on each side of midvein, arising along midvein with proximal veins becoming faint or anastomosing before reaching apex, abaxially raised, adaxially slightly raised to slightly impressed, tertiary veins abaxially raised and adaxially slightly raised to slightly impressed, base cuneate, margin regularly serrulate, with 20–40 teeth per side, planar to slightly revolute, apex acute to acuminate. Inflorescences axillary and terminal, moderately dense racemes, generally from both upper and lower leaf axils and also often borne below leaves, 2–9 cm, 1–29-flowered, bud stage elongate and conspicuous in autumn; rachis slender, densely white-pubescent to -villous, rarely also ascending-setose; bracts narrowly deltoid, keeled, 2.5–4 × 2.5–3 mm, persistent, abaxially glabrous, adaxially white-strigillose or -ascending-pubescent, margin ciliolate, apex sharply acute. Pedicel 2–7 mm, white-pubescent and rarely also setose; bracteoles subapical or usually apical, deltoid, 1.8–2.5 × 1.3–1.8 mm, otherwise similar to bracts. Calyx 2–3.2 mm; lobes 5, deltoid, 1.5–2.8 × 1.2–1.9 mm, outside glabrous, inside white-sericeous, margin ciliolate, apex sharply acute. Corolla white or occasionally pinkish white, light green, or light yellow, urceolate to subglobose, 3.5–5 × 2.5–4.5 mm, outside glabrous, inside densely white-pilose; lobes 5, oblong, 0.6–1 mm. Staminodes (in female flowers) ca. 2 mm. Stamens 10; filaments 1.5–2 mm, gradually dilated medially from apex, sparsely pilose; anthers 1.3–1.5 mm, awns 0.4–0.8 mm. Ovary white-lanate or -hirtellous; style 2–5 mm, glabrous. Calyx at fruiting dark purple to black, fleshy; lobes erect, pale-edged. Capsule 2–6 mm in diam., sericeous.

SELECTED ILLUSTRATIONS.—R.C. Fang, Fl. Reipubl. Popularis Sin. 57(3):54 t. 16(3–7). 1991; *ibid.*, 56 t. 17(1–4, as *G. forrestii*); G.H. Zhu & L.B. Zhang, eds. Fl. China Ill. 14: t. 656(3–7). 2006; *ibid.*, 661(1–5).

PHOTOGRAPHIC IMAGE.—Figure 16.

PHENOLOGY.—Fl. Oct–Jun, fr. Apr–Oct.

DISTRIBUTION AND HABITAT.—Subtropical evergreen broadleaf forests, coniferous forests, mixed forests, thickets; 1250–2650(–3000) m. In GLGS: CHINA. Xizang: Zayü Xian. Yunnan: Fugong Xian (Lishadi Xiang, Lumadeng Xiang, Maji Xiang, Shangpa Zheng), Gongshan Xian



FIGURE 16. Infructescences of *Gaultheria fragrantissima*. Photo by P. Fritsch.

(Bingzhongluo Xiang, Cikai Zheng, Dulongjiang Xiang), Longling Xian (Longjiang Xiang), Longyang Qu (Lujiang Xiang), Tengchong Xian (Jietou Xiang, Mazhan Xiang, Qingshui Xiang, Shangyun Xiang, Tengyue Zheng, Wuhe Xiang, Xinhua Xiang), MYANMAR. Kachin: Myitkyina District (Hsawlaw District), Putao District (Nogmung Township); Figure 17. Outside of GLGS: Xizang, Yunnan [Bhutan, India, Malaysia, Myanmar, Nepal, Sri Lanka, N Vietnam].

CHINESE NAME.—芳香白珠 fang xiang bai zhu

GAOLIGONG SHAN SPECIMENS EXAMINED: CHINA. XIZANG: ZAYŪ XIAN. A mtn. close to the city, 2650 m, 18 Jun 1973, QX 73-191 (KUN). YUNNAN: E slope of Gaoligong Shan, 2120 m, 25 May 1964, NT 9075 (KUN). FUGONG XIAN. Lishadi Xiang. Niwaluo Cun, vicinity of Luweide village, above the Nujiang, E side of Gaoligong Shan, 1810 m, 17 Aug 2005, GLGS 27742 (CAS). Lumadeng Xiang. Ca. 12 km from the Nujiang on the rd to Yaping Pass, E side of Gaoligong Shan, ca. 27 direct km N of Fugong City, 1969 m, 26 Apr 2004, GLGS 19536 (CAS); Cao He, ca. 6 km from the Nujiang on rd to Yaping Pass, E side of Gaoligong Shan, ca. 25 direct km N of Fugong City, 1675 m, 26 Apr 2004, GLGS 19546 (CAS); along S fork of Yamu River on rd from the Nujiang to Yaping Pass, E side of Gaoligong Shan, ca. 25.2 direct km N of Fugong City, 1608 m, 25 Apr 2004, GLGS 19824 (CAS). Maji Xiang. Mujiatia Cun, vicinity of Mujiatia Village close to the Nujiang, E side of Gaoligong Shan, 1380 m, 15 Aug 2005, GLGS 27585 (CAS). Shangpa Zheng. 2300 m, 27 Oct 1933, Tsai 54947 (A); 2000 m, 22 Sep 1934, Tsai 56578 (A). GONGSHAN XIAN. Along the Pu La He from Gongshan to Dulongjiang, 1750 m, 7 May 1979, NE 79-36 (KUN); Qi Qu (the seventh district) to Bai Zi Di, 1900 m, 8 May 1979, NE 79-46 (KUN); E slope of Gaoligong Shan, 2200 m, 28 Jul 1982, QX 8827 (KUN).

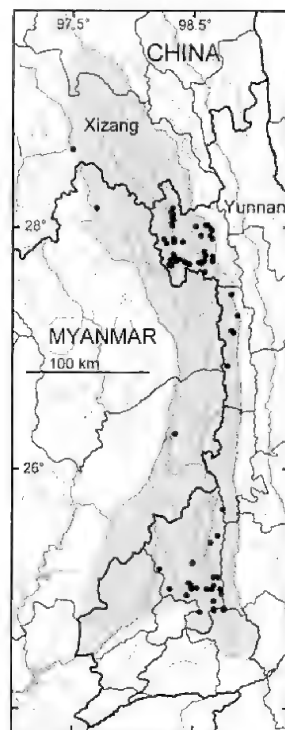


FIGURE 17. Distribution map of *Gaultheria fragrantissima* in the GLGS region.

Bingzhongluo Xiang. From Bingzhongluo to Shi Meng Guan, 1650 m, 10 Sep 1997, *GLGS 8816* (E); same location, 1650 m, 14 Sep 1997, *GLGS 9142* (E); same location, 1720–1760 m, 6 Jul 2000, *GLGS 12048* (CAS, KUN); *GLGS 12061* (CAS, KUN); Shuangla, E side of Gaoligong Shan, rd from Gongshan to Bingzhongluo, 1650 m, 17 Apr 2002, *GLGS 14487* (CAS, KUN); Puhuasigou, E side of Gaoligong Shan, rd from Bingzhongluo to Stone Gate, 1710 m, 21 Apr 2002, *GLGS 14590* (CAS, KUN); Dalaqing, E side of Gaoligong Shan, rd from Gongshan to Bingzhongluo, 1650 m, 25 Apr 2002, *GLGS 14704* (CAS, KUN); vicinity of Fucui, N side of Nianwaluo He, ca. 10.8 direct km WSW of Bingzhongluo, E side of Gaoligong Shan, 2780 m, 1 Sep 2006, *GLGS 31751* (CAS); vicinity of Xiaochala, ca. 1 km NW of mouth of the Shuangla He and ca. 25.5 direct km N of Gongshan, rd from Gongshan to Bingzhongluo, W side of the Nujiang, 1700 m, 20 Aug 2006, *GLGS 33742* (CAS); same data, *GLGS 33750* (CAS); Bing Zhong Luo River, E slope of Gaoligongshan, 1750–2500 m, 1 Aug 1979, *NE 79-1242* (KUN); same data, *NE 79-1249* (KUN); from Bingzhongluo to Bing Da, 1600–1700 m, 4 Jul 1982, *QX 7944* (KUN); Salwin Valley, SW of Champutong, 1800 m, 24 Jun 1934, *Yü 19140* (A, E). **Cikai Zheng.** 1700–1900 m, 3 Oct 1940, *Feng 8169* (KUN); Dangdan Park, just W of Gongshan, W side of the Nujiang, 1600 m, 6 Nov 1990, *GLGS 201* (CAS, KUN); Qiqi to Dong Shao Fang, 2000 m, 15 Oct 1996, *GLGS 7569* (KUN); E side of Gaoligong Shan, Dangdan Park above Gongshan, 1600–1900 m, 29 Jun 2000, *GLGS 11768* (CAS, KUN); same data, *GLGS 11770* (CAS, KUN); E side of Gaoligong Shan, W of Gongshan and E of Qiqi along the Pula He, vicinity of Qiqi Bridge, 1850 m, 10 Jul 2000, *GLGS 12213* (CAS, KUN); E side of Gaoligong Shan, W of Gongshan and W of Qiqi, along the Pula He, trail to Dongshao Fang and Dulongjiang Valley, 2200 m, 10 Jul 2000, *GLGS 12246* (CAS, KUN); E side of Gaoligong Shan, W of Gongshan, S side of the Pula He directly opposite Qiqi, 2000–2150 m, 11 Jul 2000, *GLGS 12270* (CAS, KUN); Heiwadi, E side of Gaoligong Shan, along the Pula He on new rd to Dulongjiang Valley, 2400 m, 12 Apr 2002, *GLGS 14144* (CAS, KUN); Yimaluo, E side of the Salween River, along trail to Wild Ox Valley, 2020 m, 16 Apr 2002, *GLGS 14361* (CAS, KUN); Heiwadi, E side of Gaoligong Shan, along the Pula He on new rd to Dulongjiang Valley, 2020 m, 20 Apr 2002, *GLGS 14518* (CAS, KUN); E side of Gaoligong Shan, W of Gongshan, along the Pula He on trail from Gongshan to Qiqi and Dulongjiang Valley, 2020 m, 29 Apr 2002, *GLGS 14751* (CAS, KUN); Black Mtn., Dangdan Park directly W and above Gongshan, E side of Gaoligong Shan, 1780 m, 30 Sep 2002, *GLGS 15630* (CAS, KUN); Dangdan Park directly W and above Gongshan, E side of Gaoligong Shan, 1700 m, 24 Sep 2002, *GLGS 16548* (CAS, KUN); vicinity of Mangzhou Wadi, S side of the Danzhu He, ca. 13.6 direct km WSW of Danzhu Cun and ca. 14.8 direct km SW of Gongshan, E side of Gaoligong Shan, 3000 m, 12 Aug 2006, *GLGS 33104* (CAS); vicinity of Heiwadi Qiao on rd from Gongshan to Kongdang, ca. 9.5 direct km NW of Gongshan, E side of Gaoligong Shan, 1790 m, 18 Aug 2006, *GLGS 33545* (CAS); vicinity of Dimupo, ca. 7 direct km WNW of Gongshan on rd from Gongshan to Kongdang, E side of Gaoligong Shan, 2530 m, 17 Aug 2006, *GLGS 33693* (CAS); the hill behind the city, 1650 m, 27 Apr 1979, *NE 79-3* (KUN); from Gongshan to Dulongjiang, E slope of Gaoligongshan, 1600–1700 m, 17 Jul 1982, *QX 7994* (KUN); same locality, 1700 m, 17 Jul 1982, *QX 8028* (KUN). **Dulongjiang Xiang.** W bank of Dulongjiang, the fourth village, 1300 m, 2 Nov 1959, *Feng 24715* (KUN); Dulongjiang Valley, 22 Nov 1990, *GLGS 780* (CAS, KUN); vicinity of Meiliwang, along trail from Bapo to Gongshan, E side of the Dulongjiang, 1500 m, 23 Nov 1990, *GLGS 835* (CAS, KUN); vicinity of Jimudang, ca. 5 m NW of Bapo, W side of the Dulongjiang, 1400 m, 6 Dec 1990, *GLGS 885* (CAS, KUN); W bank of the Dulongjiang, 1400 m, 11 Dec 1990, *GLGS 996* (KUN); vicinity of Maku, southern region of Dulongjiang Valley, W side of the Dulongjiang, 1780 m, 15 Dec 1990, *GLGS 1071* (CAS, KUN); same locality, 2080 m, 16 Dec 1990, *GLGS 1108* (CAS, KUN); Ma Bi Luo, 1310 m, 30 Dec 1990, *GLGS 1394* (KUN); Mei Li Wang, 1800 m, 7 Jan 1991, *GLGS 1653* (KUN); Muo Qie Wong, 1608 m, 9 Jan 1991, *GLGS 1748* (KUN); same location, 1560 m, 10 Jan 1991, *GLGS 1830* (KUN); Mei Li Wong, 1800 m, 10 Jan 1991, *GLGS 1930* (KUN); Song Dang Luo, 1600 m, 14 Jan 1991, *GLGS 1996* (KUN); Kong Dang, 1445 m, 20 Nov 1990, *GLGS 2050* (KUN); vicinity of Longyuan, ca. 6 km S of Dizhengdang, W side of the Dulongjiang, 1690 m, 23 Nov 1990, *GLGS 2175* (CAS, KUN); between Dizhengdang and Xiongdang, along Kelaoluo River which is the northwestern tributary of the Dulongjiang, 1980 m, 29 Nov 1990, *GLGS 2234* (CAS, KUN); Dan Dang Wang He, 1400 m, 16 Jan 1991, *GLGS 3144* (KUN); Dan Dang He, 1900 m, 18 Jan 1991, *GLGS 3275* (KUN); Ma Bi Dang, 1300 m, 21 Feb 1991, *GLGS 4076* (KUN); Kong Dang, 1480 m, 1 Mar 1991, *GLGS 4114* (KUN); Mong Dang, 1310 m, 4 Mar 1991, *GLGS 4176* (KUN); Ma Ku, 1800 m, 6 Mar 1991, *GLGS 4202* (KUN); same location, 1830 m, 6 Mar 1991, *GLGS 4203* (KUN); same location, 1850 m, 7 Mar 1991, *GLGS*

4232 (KUN); Si La Luo, 1450 m, 13 Mar 1991, *GLGS* 4713 (KUN); Qia Wu Dang, 2100 m, 22 Mar 1991, *GLGS* 4810 (KUN); Wang Mei Dong, 2100 m, 26 Mar 1991, *GLGS* 5158 (KUN); Lang Ben Dang, 2100 m, 27 Mar 1991, *GLGS* 5256 (KUN); Xi Shao Fang, 2500 m, 30 Mar 1991, *GLGS* 5338 (KUN); Long Yuan, 1700 m, 30 Mar 1991, *GLGS* 5366 (KUN); same location, 1650 m, 11 Apr 1991, *GLGS* 5435 (KUN); same data, *GLGS* 5471 (KUN); same location, 1630 m, 11 Apr 1991, *GLGS* 5522 (KUN); Di Zheng Dang, 1850 m, 13 Apr 1991, *GLGS* 5677 (KUN); same location, 1780 m, 14 Apr 1991, *GLGS* 5773 (KUN); same location, 1800 m, 16 Apr 1991, *GLGS* 5984 (KUN); Wang Mu La Ka, 2400 m, 18 Apr 1991, *GLGS* 6058 (KUN); Si Fang La Ka, 2000 m, 21 Apr 1991, *GLGS* 6273 (KUN); N of the second team, 2300 m, 16 May 1991, *GLGS* 6841 (KUN); Mei Li Wang, 1800 m, 21 May 1991, *GLGS* 7008 (KUN); Xianjiudang, W side of Gaoligong Shan, along Dulongjiang Valley on trail from Kongdang to Dizhengdang, 1560 m, 23 Jul 2002, *GLGS* 15232 (CAS, KUN); vicinity of Nengpula, E side of the Dulongjiang just E of Hongxin Qiao (Red Star bridge) ca. 0.5 km SW of Bapo, 1330 m, 29 Oct 2004, *GLGS* 20752 (CAS); ca. 0.6 km NW of Meiliwang on trail between Bapo and Xixiaofang on trail from Bapo to Gongshan via Qiqi, W side of Gaoligong Shan, 1660 m, 31 Oct 2004, *GLGS* 21311 (CAS); N side of Shilawa River, W side of the Dulongjiang ca. 0.5 direct km SW of Dizhengdang (Lengdang) and ca. 22 direct km N of Kongdang, 1910 m, 29 Oct 2004, *GLGS* 21446 (CAS); W side of the Dulongjiang, ca. 2 direct km SSW of Dizhengdang (Lengdang) and ca. 20.5 direct km N of Kongdang, 1930 m, 30 Oct 2004, *GLGS* 21560 (CAS); Bailai Zhai, Longyuan Cun, W side of the Dulongjiang, ca. 7 direct km S of Dizhengdang (Lengdang) and ca. 15.5 direct km N of Kongdang, 1720 m, 28 Oct 2004, *GLGS* 21618 (CAS); Mabiluo on E side of the Dulongjiang just N of Mabitang, ca. 4 km N of Bapo, S side of river along input channel to hydroelectric station, 1380 m, *GLGS* 21930 (CAS); W side of the Dulongjiang Valley, ca. 1 direct km NW of Maku and ca. 4.5 direct km NE of Myanmar border, 2140 m, 18 Aug 2006, *GLGS* 32505 (CAS); from Dulongjiang to San Dui (the third team), 10 Jul 1979, *NE* 79-1169 (KUN); 1500 m, 22 Aug 1982, *QX* 9399 (KUN); Kiukiang Valley, Mt. Ching Ting La Ka, 1800 m, 26 Jul 1938, *Yü* 19492 (A, E, KUN). **LONGLING XIAN. Longjiang Xiang.** Yun Long Shang, Fu Long Si, 1500 m, 28 Nov 1958, *J. Chen* 657 (KUN); vicinity of Xiaoheshan, along trail on S side of Hwy. S317 (new hwy. from Baoshan to Tengchong via Nankang Yakou) at Km 23.5, W side of Gaoligong Shan, 2037 m, 23 May 2005, *GLGS* 24613 (CAS); vicinity of Xiaoshuihe, Xiaoheshan Provincial Nature Reserve area, W side of Gaoligong Shan, 1990 m, 27 May 2005, *GLGS* 25065 (CAS); 1800 m, 11 Apr 1934, *Tsai* 55732 (A, E); 1700 m, 16 Mar 1934, *Tsai* 56477 (A, E, KUN). **LONGYANG QU. Lujiang Xiang.** Nankang Botanic Garden (Lihuipo), summit of Gaoligong Shan, 2170 m, 20 Nov 2000, *GLGS* 13302 (CAS). **TENGCHONG XIAN.** Hills SW of Tengyueh, 5700 ft., May 1912, *F* 7466 (A, E, K); hills E of Tengyueh, 5000 ft., May 1912, *F* 7659 (A, E, K); same location, 7000 ft., Nov 1912, *F* 9335 (A, E, K); hills around Tengyueh, Nov 1912, *F* 9389 (E); hills E of Tengyueh, 6–7000 ft., Feb 1913, *F* 9591 (A, E, K); hills NW of Tengyueh, 7000 ft., Feb 1913, *F* 9694 (A, E, K); hills S of Tengyueh, 6000 m, Mar 1913, *F* 9792 (A, E, K); Shweli-Salwin divide, 8–9000 ft., Apr 1914, *F* 12344 (E, K); hills around Tengyueh, 5000–7000 ft., Jul 1919, *F* 18098 (A, E, K); bank of the Shweli, 8000 ft., Mar 1931, *F* 29457 (E [2]); Shweli-Salwin divide, E of Tengyueh, 8000 ft., Jun 1931, *F* 29803 (E); Shweli River drainage basin to summit of Shweli-Salween watershed, E of Tengyueh, 15 Jan 1923, *Rock* 7887 (A); Shweli River drainage basin and environs of Tengyueh, 1800 m, Feb 1923, *Rock* 7902 (A). **Jietou Xiang.** Dayuanzi Cun, W of Gaoligong Shan ridge, ca. 2 direct km SW of Dayuanzi, 1590 m, 15 May 2006, *GLGS* 28202 (CAS); Xinzhuang Cun, vicinity of Lijiapo, ca. 5.9 direct km ENE of Jietou, W side of Gaoligong Shan, 1940 m, 23 May 2006, *GLGS* 29464 (CAS); same data, *GLGS* 29465 (CAS). **Mazhan Xiang.** Bao Jia Xiang, 1850 m, 15 Apr 1985, *Fragrances Resource Expedition* 85-229 (KUN); Dakong Shan Volcano, 2040 m, 2 Jun 2006, *GLGS* 29886 (CAS); same data, *GLGS* 29889 (CAS); same location, 1940 m, 2 Jun 2006, *GLGS* 29895 (CAS). **Qingshui Xiang.** Liangying Cun, vicinity of Huangguaqing, 1470 m, 1 Jun 2006, *GLGS* 30853 (CAS); data location, *GLGS* 30855 (CAS). **Shangyun Xiang.** Pingdi Cun, near Guanggui Village, W side of Gaoligong Shan, N of old rd from Baoshan to Tengchong via Dashaoping on dirt track N of bridge across the Longchangjiang, 1335 m, 30 Aug 2003, *GLGS* 18071 (CAS); Taipingpu area, W side of Gaoligong Shan on old trail (southern silk road) just N and above old rd from Baoshan to Tengchong via Dashaoping, 2300 m, 4 Sep 2003, *GLGS* 18688 (CAS). **Tengyue Zheng.** Bao Feng Si, 1850–2000 m, 27 Dec 1958, *J. Chen* 1029 (KUN); vicinity of Baofeng Si, NW outskirts of Tengchong City, 1790 m, 31 May 2006, *GLGS* 29757 (CAS). **Wuhe Xiang.** Vicinity of Tuting Village, E side of the Longchuanjiang, W side of Gaoligong Shan, 1250 m, 23 May 2005, *GLGS* 24565 (CAS). **Xinhua Xiang.** Longjin Cun,

NE corner of Xinhua Xiang near border with Puchuan Xiang, W of the Longchangjiang and W of S end of Gaoligong Shan, 1940 m, 5 Jun 2006, *GLGS 31118* (CAS). **MYANMAR. KACHIN: MYITKYINA DISTRICT. Hsawlaw Township.** Ngawchang Valley and tributaries, near Htawgaw, 7000 ft., 7 Mar 1939, *KW 381* (A). **PUTAO DISTRICT. Nongmung Township.** Adung Valley, 6000 ft., 16 Feb 1931, *KW 9243* (A); same locality, 7000–8000 ft., 16 Mar 1931, *KW 9305* (A).

9. *Gaultheria griffithiana* Wight, *Calcutta J. Nat. Hist.* 8:176. 1847. TYPE.—BHUTAN. *W. Griffith 3483* (syntypes: K!, K; isotype: GH [image!]).

Gaultheria caudata Stapf, *Bot. Mag.* 154: t. 9228. 1931. TYPE.—*Bot. Mag.* 154: t. 9228. 1931; specimens, if such exist, not seen.

Gaultheria lasiocarpa T.Z. Xu, *Acta Phytotax. Sin.* 30:175. 1992. TYPE.—CHINA. Sichuan: Miyi, 3200–3300 m, 7 July 1983, *Qinghai-Xizang Expedition 11831* (holotype: PE).

Gaultheria miyiensis T.Z. Xu, *Acta Phytotax. Sin.* 30:178. 1992. TYPE.—CHINA. Sichuan: Miyi, 2700 m, 6 June 1990, *T.Z. Xu Mi-003* (holotype: KUN!).

Shrubs or rarely small trees, 1–6 m tall, erect to arching, with strong wintergreen odor, gynodioecious. Branchlets elongate, terete to slightly angulate, glabrous or rarely sparsely setulose. Petiole 4–12 mm, glabrous or occasionally white-puberulent; leaf blade elliptic, oblong-elliptic, lanceolate-elliptic, or oblanceolate-elliptic, 6.7–15.8 × 2.5–5.1 cm, 2.4–5.4 × as long as wide, coriaceous, abaxially greenish brown to brown and dark red- to brown-gland-dotted or occasionally -papillose-setulose, adaxially white-puberulent proximally along midvein, midvein abaxially prominent and adaxially sulcate, secondary veins 3–6 on each side of midvein, arising along midvein with proximal veins becoming faint or anastomosing before reaching apex, abaxially raised, adaxially planar to impressed, tertiary veins abaxially raised and adaxially planar to impressed, base cuneate to rounded, margin regularly serrulate, with 40–75 teeth per side, planar to slightly revolute, apex narrowly acuminate to caudate. Inflorescences axillary and terminal, rather open racemes, generally from both the upper and lower leaf axils, 1.2–8 cm, 4–25-flowered, bud stage elongate and conspicuous in autumn; rachis slender, white-pubescent to -villous; bracts ovate to ± hemispherical, not keeled, 1.7–4.2 × 2.2–3 mm, persistent, abaxially glabrous, adaxially white-sericeous or -strigillose, margin ciliolate, apex broadly obtuse to rounded. Pedicel 3–9 mm, white-pubescent; bracteoles medial or submedial, deltoid-ovate, keeled, 1.5–2 × 1–1.4 mm, apex acuminate, otherwise similar to bracts. Calyx 2.5–3.5 mm; lobes 5, ovate-deltoid, 1.5–2.8 × 1.3–1.8 mm, outside glabrous, inside white-tomentose at least apically, margin ciliolate, apex obtuse to acute. Corolla white to green, occasionally pink- or purple-tinged, campanulate to subglobose, 4–6 × 3–7 mm, glabrous; lobes 5, broadly deltoid, 0.8–2.5 mm. Staminodes (in female flowers) ca. 1 mm. Stamens 10; filaments ca. 2 mm, gradually dilated medially from apex, glabrous; anthers 1.2–1.4 mm, awns 0.7–1.1 mm. Ovary white-sericeous; style 2–3.5 mm, proximally hirtellous. Calyx at fruiting dark purple to black, thin; lobes incurved, pale-edged. Capsule 3–8 mm in diam., sericeous.

SELECTED ILLUSTRATIONS.—O.S. Stapf, *Bot. Mag.* 154: t. 9228. 1931 (as *G. caudata*). R.C. Fang, *Fl. Reipubl. Popularis Sin.* 57(3):57 t. 17(5–8). 1991; G.H. Zhu & L.B. Zhang, eds. *Fl. China Ill.* 14: t. 661(6–10). 2006.

PHOTOGRAPHIC IMAGE.—Figure 18.

PHENOLOGY.—Fl. Apr–Sept, fr. May–Dec.

DISTRIBUTION AND HABITAT.—Subtropical evergreen broadleaf forests, mixed evergreen and deciduous broadleaf forests, deciduous broadleaf forests, thickets; 2160–3300 m. In *GLGS*: CHINA. Yunnan: Fugong Xian (Lishade Xiang, Lumadeng Xiang, Shangpa Zheng), Gongshan Xian (Bingzhongluo Xiang, Cikai Zheng, Dulongjiang Xiang), Longyang Qu (Bawan Xiang,



FIGURE 18. Inflorescences of *Gaultheria griffithiana*. Photo by L. Zhou.

Lujiang Xiang, Mangkuan Xiang), Lushui Xian (Luobenzhou Xiang, Luzhang Zheng, Pianma Xiang), Tengchong Xian (Houqiao Zheng, Jietou Xiang, Mingguang Xiang, Ruidian Xiang, Shangying Xiang, Shangyun Xiang, Wuhe Xiang), MYANMAR. Kachin: Myitkyina District (Chipwi Township, Hsawlaw Township), Putao District (Nogmung Township); Figure 19. Outside of GLGS: SW Sichuan, Xizang, Yunnan [Bhutan, NE India, Myanmar, Nepal, Vietnam].

CHINESE NAME.—尾叶白珠 *wei ye bai zhu*

GAOLIGONG SHAN SPECIMENS EXAMINED: CHINA. YUNNAN:

FUGONG XIAN. Ya Qiang Ke, E of Gaoligongshan, 2000 m, 12 Sep 1979, Z.G He & B.Y. Zhang 622 (KUN); Gu Qiao Da Dui, Qiao Mi Gu Lu, 2600 m, 10 Jun 1982, QX 7247 (KUN). **Lishadi Xiang.** Above forest logging camp ca. 20 km W of Salween River crossing, 2600 m, 21 Oct 1996, GLGS 7885 (E, KUN); Ya Ping, 2500 m, 31 Oct 1996, GLGS 7905 (KUN); vicinity of Shibali Logging Station on rd from the Nujiang to Yaping Pass, E side of Gaoligong Shan, 2485 m, 28 Apr 2004, GLGS 20029 (CAS); Yaping, Shibali Logging Station on rd from the Nujiang to Yaping Pass, 3007 m, 2 May 2004, GLGS 20137 (CAS); vicinity of N fork of the Yamu River, ca. 0.7 km E of Shibali Logging Station, on rd from the Nujiang to Yaping Pass, E side of Gaoligong Shan, 2467 m, 2 May 2004, GLGS 20247 (CAS); between the Nujiang and Shibali Logging Station, ca. 6.5 km W of Shibali, on rd from the Nujiang to Yaping Pass, E side of Gaoligong Shan, 2868 m, 8 May 2004, GLGS 20401 (CAS); Yaduo Cun, above Shibali to Myanmar border at Yaping Yakou, N side of N fork of the Yamu He, E side of Gaoligong Shan, 2750

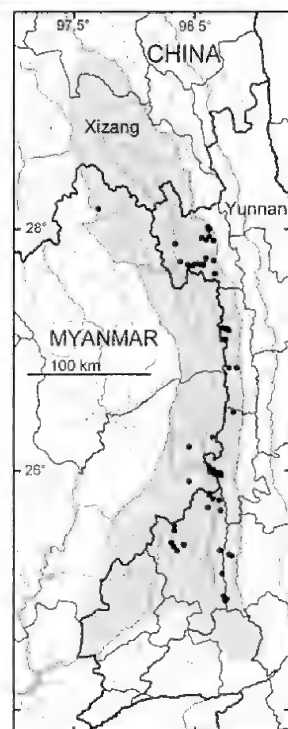


FIGURE 19. Distribution map of *Gaultheria griffithiana* in the GLGS region.

m, 10 Aug 2005, *GLGS 26900* (CAS); same locality, 2770 m, 15 Aug 2005, *GLGS 28326* (CAS); Yaduo Cun, vicinity of Shibali, N side of N fork of the Yamu He, E side of Gaoligong Shan, 2510 m, 16 Aug 2005, *GLGS 28462* (CAS). **Lumadeng Xiang**, Rd along S fork of the Yamu River, rd to Armero Pass, ca. 23 km SW of the confluence of N and S forks of the Yamu, E side of Gaoligong Shan, 3022 m, 2 May 2004, *GLGS 20283* (CAS); Yaping Cun, above southern Shibali, along S fork of Yamu He, rd to Amero Pass, E side of Gaoligong Shan, 2800 m, 14 Aug 2005, *GLGS 27273* (CAS); Yaping Cun, rd above old Shibali on N side of S fork of the Yamu He, E side of Gaoligong Shan, 2540 m, 22 Aug 2005, *GLGS 28857* (CAS). **Shangpa Zheng**, 2700 m, 17 Oct 1933, *Tsai 54448* (A, KUN); 2500 m, 19 Oct 1933, *Tsai 54473* (A). **GONGSHAN XIAN**, Si Qu (the fourth district), 3150 m, 24 May 1960, *NT 8528* (KUN); E slope of Gaoligongshan, 2600 m, 29 May 1960, *NT 9095* (KUN); Chih-tse-lo, 3000 m, 3 Sep 1933, *Tsai 54104* (A, E); same locality, 3200 m, 30 Aug 1932, *Tsai 58322* (A). **Bingzhongluo Xiang**, Yi Qi (the first district), 13 Apr 1959, *Feng 24557* (KUN [2]); Gongdan Holy Hills, E side of Gaoligong Shan, trail from Bingzhongluo to top of Holy Hills, 2500 m, 17 Apr 2002, *GLGS 14454* (CAS, KUN); Gong Dang (God's Mtn.) beyond end of rd to a marble quarry just SW of Bingzhongluo, E side of Gaoligong Shan, 2620 m, 9 Oct 2002, *GLGS 17105* (CAS, KUN); W side of the Nujiang near first turn of the river between Gongshan and Bingzhongluo, 2250 m, 13 Nov 2004, *GLGS 23109* (CAS); Gongdang Sacred Mtn., ca. 2.8 direct km S of Bingzhongluo, E side of Gaoligong Shan, 2480 m, 13 Nov 2004, *GLGS 23145* (CAS); Qiao Na Tong to Bai Mang Xue Shan, 2400 m, 29 May 1960, *NT 8807* (KUN); Zheng Ta, 2300 m, 29 May 1979, *NE 79-255* (KUN); Qi Na, 2400–2600 m, 20 Jun 1982, *QX 7407* (KUN); Song Ta, 3000–3400 m, 25 Jun 1982, *QX 7557* (KUN). **Cikai Zheng**, Hei Pu Shan, 22 Oct 1940, *Feng 8643* (KUN); Qiqi to Dongshaofang, 2730 m, 14 Dec 1996, *GLGS 7733* (KUN); E side of Gaoligong Shan, in Dangdan Park above Gongshan, 1600–1900 m, 29 Jun 2000, *GLGS 11752* (CAS, KUN); E side of Gaoligong Shan, W of Gongshan, along a branch of the Pula He, W of Rizhidi Bridge, trail from Qiqi to Dongshao Fang and Dulongjiang Valley, 2100–2200 m, 11 Jul 2000, *GLGS 12293* (CAS, KUN); E side of Gaoligong Shan, W of Gongshan, along the Pula He, trail from Qiqi to Dongshao Fang and Dulongjiang Valley, 2770–3050 m, 15 Jul 2000, *GLGS 12582* (CAS, KUN); Dan Zhu, Alamen, E side of Gaoligongshan, 2200 ft., 25 May 2000, *GLGS 13735* (CAS, KUN); E side of Gaoligongshan, W of Gongshan, along the Pula He, trail from No. 12 Bridge to Dongshaofang and Dulongjiang Valley, 2900 m, 1 May 2002, *GLGS 14793* (CAS, KUN); vicinity of Dimupo, ca. 7 direct km WNW of Gongshan, rd from Gongshan to Kongdang, E side of Gaoligong Shan, 2530 m, 17 Aug 2006, *GLGS 33681* (CAS); same data, *GLGS 33699* (CAS); Qiqi trail to 12th bridge, 2400–2500 m, 3 Jun 2006, *Lu 6-39* (CAS). **Dulongjiang Xiang**, Xui Ba La Ka, 2200 m, 15 May 1991, *GLGS 5912* (KUN); Wang Nu La Ka, 2700 m, 18 Apr 1991, *GLGS 6056* (KUN); Shang Hong, 2800 m, 20 Apr 1991, *GLGS 6437* (KUN); from Dulongjiang to Gongshan, 1979, *Q. Lin 790673* (KUN); Kong Mu Da Dui, 1560–3500 m, 16 Jul 1973, *Q. Lin 790963* (KUN). **LONGYANG QU**. **Bawan Xiang**, Vicinity of Dahaping Yakou on rd from Baoshan to Tengchong, E side of Gaoligong Shan, 2410 m, 30 May 2005, *GLGS 26076* (CAS); same data, *GLGS 26086* (CAS). **Lujiang Xiang**, Bawan Cun, Dasheyao, E side of Gaoligong Shan, old rd from Baoshan to Tengchong via Dahaoping, 2240 m, 2 Sep 2003, *GLGS 18574* (CAS). **Mangkuan Xiang**, Baihualing, Daluchang National Forest, E side of the Gaoligongshan, 25 Nov 2000, *GLGS 13445* (CAS, KUN); Baihualing, 2200 m, 12 May 1923, *X.C. Shi 408* (KUN [2]). **LUSHUI XIAN**. **Luoben-zhuo Xiang**, Vicinity of Bifu bridge, ca. 32.7 direct km S of Fugong City and ca. 7.7 direct km W of the Nujiang, E side of Gaoligong Shan, 2640 m, 1 May 2004, *GLGS 20831* [mistakenly recorded as Fugong Xian, Pihe Xiang on the label but all other data are correct] (CAS). **Luzhang Zheng**, Rd between the Salween and Pianma, W side of Gaoligong Shan, 2700 m, 15 Oct 1998, *GLGS 10427* (CAS, KUN); Yao Jia Ping, 2440 m, 25 Oct 1996, *GLGS 8018* (KUN); rd between Lushui and Pianma Yakou at Km 53 from turn off on Liuku-Fugong rd., E side of Gaoligong Shan, 2850 m, 15 Oct 2002, *GLGS 15971* (CAS, KUN); vicinity of Yaojiaping between Lushui and Pianma Pass, E side of Gaoligong Shan, 2450 m, 11 May 2005, *GLGS 22682* (CAS); area above Yaojiaping Forest Station, Sanjiang River, E side of Gaoligong Shan, 2737 m, 18 May 2005, *GLGS 24437* (CAS); vicinity of Km 58, rd from Liuku to Pianma, E side of Gaoligong Shan, 2649 m, 19 May 2005, *GLGS 24499* (CAS); *GLGS 24505* (CAS); Yao Jia Ping, 2600 m, 23 Jul 1960, *NT 10398* (KUN). **Pianma Xiang**, 3000 m, 14 Sep 1996, *GLGS 7261* (KUN [2]); same data, *GLGS 7285* (KUN [2]); along Changyan He, E of Pianma, rd between Pianma and Lushui, W side of Gaoligong Shan, 2370 m, 15 May 2005, *GLGS 22945* (CAS); along river just E of Pianma, W side of Gaoligong Shan, 1990 m, 16 May 2005, *GLGS 22994* (CAS); Gangfang Yakou, rd from Pianma to Gangfang, W side of Gaoligong Shan, 2260 m, 15 May 2005,

GLGS 24198 (CAS); upper slopes of the Pianma River, ca. 10 km E of Pianma, W side of Gaoligong Shan, 2510 m, 16 May 2005, *GLGS 24242* (CAS). **TENGCHONG XIAN.** W flank of Shweli-Salween divide, 8000–9000 ft., Aug 1912, *F 8949* (E, K); ascent of Sansi Gorge from the Chinese side, 7000–8000 ft., Sep 1912, *F 9120* (E); Shweli-Salwin divide, Jul 1919, *F 18134* (A, E, K); same locality, Oct 1919, *F 18972* (E, K); Xian Ping He, 2200 m, 11 Oct 1983, *Q. Lin 770596* (KUN). **Houqiao Zheng (Guyong Zheng).** Vicinity of Gaoshidong in Guyong Linchang (forest farm), ca. 9.8 direct km ENE of Houqiao (Guyong), 2570 m, 27 May 2006, *GLGS 30658* (CAS); vicinity of Gaoshidong in Guyong Linchang (forest farm), ca. 11.4 direct km E of Houqiao (Guyong), 2060 m, 27 May 2006, *GLGS 30685* (CAS); 2600 m, 18 May 1964, *Wu 6647* (KUN); Dan Zha to Chang Ping Ba Tou, 2400 m, 14 Apr 1980, *L.S. Xie 853* (KUN). **Jietou Xiang.** Datang Cun, vicinity of Dahe Linggan, NNE of Datang, W side of Gaoligong Shan, 2240 m, 15 May 2006, *GLGS 30053* (CAS). **Mingguang Xiang.** Zizhi Cun, ca. 9.5 direct km NE of Zizhi, rd to Baduolin Yakou (the pass into Myanmar at border marker 8), Jiangao Shan, W side of Gaoligong Shan, 2750–2850 m, 19 May 2006, *GLGS 29210* (CAS); Zizhi Cun, rd from Zizhi to Baduolin Yakou (the pass into Myanmar at border marker 8), Jiangao Shan, W side of Gaoligong Shan, 2650 m, 20 May 2006, *GLGS 29291* (CAS); Zizhi Cun, Jiangao Shan, rd from Zizhi to Baduolin Yakou (the pass at marker 8 between China and Myanmar), W side of Gaoligong Shan, 2770 m, 23 May 2006, *GLGS 30511* (CAS); Zizhi Cun, Jiangao Shan, trail E of Baduolin Yakou (pass at marker 8 between China and Myanmar), W side of Gaoligong Shan, 3020 m, 3 May 2006, *GLGS 30558* (CAS); same data, *GLGS 30568* (CAS); Zizhi Cun, vicinity of Dazhuba on N side of a large agricultural valley in NE corner of Zizhi Cun, ca. 9.4 direct km ENE of Zizhi, W side of Gaoligong Shan, 2070 m, 23 May 2006, *GLGS 30596* (CAS). **Ruidian Xiang.** Yunfeng Cun, Yunfeng Shan, along top of ridge NE of Yunfeng Si, ca. 9.2 direct km SSW of Ruidian, 2290 m, 3 Jun 2006, *GLGS 29974* (CAS); same data, *GLGS 31011* (CAS). **Shangying Xiang.** Da Tian Po, W side of Gaoligongshan between Dahaoping and the pass dividing the Irrawadi and Salween watersheds, old rd between Baoshan and Tengchong, 2700 m, 5 Nov 1998, *GLGS 11550* (CAS, KUN); top of ridge at border between Baoshan Shi and Tengchong Xian, N and S of old rd from Baoshan to Tengchong via Dahaoping, 2400 m, 4 Sep 2002, *GLGS 18788* (CAS); Dahaowo of Dajianpo Village, SE of Dahaoping, W side of Gaoligong Shan, 2160 m, 1 Jun 2005, *GLGS 25318* (CAS). **Shangyun Xiang.** Top of ridge at border between Baoshan Shi and Tengchong Xian, N and S of old rd from Baoshan to Tengchong via Dahaoping, 2400 m, 4 Sep 2003, *GLGS 18737* (CAS); same data, *GLGS 18788* (CAS). **Wuhe Xiang.** Ridge S of the pass at top of Gaoligong Shan on old rd from Baoshan to Tengchong via Dahaoping, W side of Gaoligong Shan, 2525 m, 5 Sep 2003, *GLGS 18842* (CAS); above Dahaoping along ridge S of Dahaoping Yakou (pass at the border between Tengchong Xian and Longyang Qu), W side of Gaoligong Shan, 2405 m, 30 May 2005, *GLGS 25120* (CAS); ridge at the pass of Dahaoping by following trail to N of the pass, W side of Gaoligong Shan, 2432 m, 30 May 2005, *GLGS 25199* (CAS). **MYANMAR. KACHIN: MYITKYINA DISTRICT. Chipwi Township.** N'Maikha-Salwin divide, 11000 ft., Jun 1931, *F 29649* (BM, E); Htaawgaw, valley of Naung Chaung Laohi, 9000 ft., 14 May 1914, *KW 1590* (E). **Hsawlaw Township.** Ridge above Laktang, 9000 ft., 8 Jun 1919, *KW 3201* (E). **PUTAO DISTRICT. Nogmung Township.** Adung Valley, 8000 ft., 14 Apr 1931, *KW 9408* (A); same locality, 31 May 1931, *KW 9488* (A); same locality, 1 Jun 1931, *KW 9573* p.p. (A).

10. *Gaultheria hookeri* C.B. Clarke, Fl. Brit. India 3:458. 1882. TYPE.—INDIA. Sikkim: Lachen, 10–11000 ft., 2 August, 1849, *J.D. Hooker s.n.* (lectotype, here designated: K!).

The protologue of *Gaultheria hookeri* mentions both (Mt.) Lachen and Choongtam collections by J.D. Hooker. The four sheets of the type material that we have seen all have C.B. Clarke's handwriting, but otherwise no indication of type. We have chosen the 2 August 1849 Lachen collection from K (one sheet) as lectotype because it has both flowering and fruiting material and is on its own sheet. Other sheets have only flowering material or contain two labels with different dates of collection.

Gaultheria hookeri C.B. Clarke var. *angustifolia* C.B. Clarke, Fl. Brit. India 3:458. 1882. TYPE.—INDIA. Sikkim: Yakla, 9–10000 ft., 10 May 1876, *C.B. Clarke 27837A* (holotype: K!).

Gaultheria stapfiana Airy Shaw, Kew Bull. 1952:171. 1952. TYPE.—CHINA. Yunnan: [Tengchong Xian],

western flank of the Shweli-Salwin divide, 25°40'N, 2700 m [Gaoligong Shan], June 1919, *G. Forrest 18021* (holotype: E!; isotypes: A!, K!).

Gaultheria veitchiana Craib, Gard. Chron. ser. 3, 52:188. 1912. TYPE.—CHINA. Western China, 1800–3000 m, May 1904, *E.H. Wilson 3916* (lectotype, here designated: K!; isolectotypes: A [3; images!]).

Both *E.H. Wilson 1627* and *3916* were cited in the protologue of *Gaultheria veitchiana*, without specific indication of type. Rehder and Wilson (1913) cited *3916* as “type,” but did not indicate a particular duplicate of this number. We have chosen the *E.H. Wilson 3916* specimen at K as lectotype because it is a wild-collected plant, *E.H. Wilson 1627* being an ex situ collection (if it is still extant) from a plant in cultivation, and because Craib’s herbarium is K.

Shrubs 0.3–3 m tall, erect to occasionally ± prostrate, gynodioecious. Branchlets not notably elongate, terete to slightly angulate, sparsely or usually densely tawny-, ferrugineous-, or black-appressed- to ascending-setose or -villous-hirsute and often white-puberulent, occasionally nearly glabrous. Petiole 2–10 mm, at least some on each individual sparsely to densely setose or villous-hirsute; leaf blade oblanceolate to occasionally oblong-elliptic, elliptic, or obovate, 3–12.7 × (0.8–)1.3–4 cm, 1.7–3.3(–3.8) × as long as wide, subcoriaceous to coriaceous, abaxially green to brown and red- to black-gland-dotted to -appressed-setulose or -setose, adaxially glabrous or white-puberulent proximally along midvein, midvein abaxially prominent and adaxially sulcate, secondary veins 3–7 on each side of midvein, arising along midvein with proximal veins becoming faint or anastomosing before reaching apex, abaxially raised to prominent, adaxially impressed, tertiary veins abaxially raised to prominent and adaxially impressed, base cuneate to occasionally subrounded, margin regularly serrulate, with 20–40 teeth per side, planar to slightly revolute, apex acute to occasionally obtuse or shortly acuminate. Inflorescences axillary and terminal, rather open racemes, generally from the upper leaf axils, 1.5–6.5 cm, 7–24-flowered, bud stage conspicuous in autumn; rachis slender, white-pubescent or -villous; bracts broadly elliptic, ovate-elliptic, or sub-orbicular, not keeled, 2.5–6 × 2–4.5 mm, persistent, abaxially glabrous or white-pubescent, adaxially white-pubescent to -strigillose or rarely glabrous, margin ciliolate and often stipitate-glandular, apex acute to shortly acuminate. Pedicel 1–9 mm, glabrous or white-pubescent; bracteoles ± medial, deltoid-ovate, 1.7–3 × 1.2–2.1 mm, otherwise similar to bracts. Calyx 1.8–3 mm; lobes 5, deltoid to deltoid-ovate, 1.4–2.2 × 1–2 mm, outside glabrous, inside glabrous or white-puberulent, margin ciliolate, apex acute. Corolla pink, pink-magenta, or occasionally white or white with pink distally, urceolate, 3.5–5.5 × 1.8–4 mm, outside glabrous, inside white-hirsute; lobes 5, oblong, 0.5–0.7 mm. Staminodes (in female flowers) ca. 1 mm. Stamens 10; filaments 1–1.8 mm, gradually dilated submedially from apex, glabrous; anthers 0.7–1.3 mm, awns 0.4–0.8 mm. Ovary tawny- to white-hirtellous; style 1.5–3 mm, glabrous or proximally pubescent. Calyx at fruiting blue or blue flushed with white, fleshy; lobes ± erect, pale-edged. Capsule 4–6 mm in diam., sericeous.

Gaultheria hookeri var. *angustifolia* is recognized in the Flora of China (Fang and Stevens 2005) on the basis of its lanceolate or linear-lanceolate (versus elliptic) leaf blades 2–4 cm wide (versus 1–1.5 cm). Leaf blade shape and width vary continuously across the geographic distribution of the species, and we have thus placed this variety in synonymy under *G. hookeri*.

See also discussion under *Gaultheria pyrolifolia*.

SELECTED ILLUSTRATION.—T.Z. Xu, Fl. Yunnan. 4:592 t. 169(1–6). 1986.

PHOTOGRAPHIC IMAGE.—Figure 20.

PHENOLOGY.—Fl. May–Oct, fr. Jun–Nov.

DISTRIBUTION AND HABITAT.—Deciduous broadleaf forests, coniferous forests, open slopes, mountain summits, meadows, thickets; (1900–2100)2400–4400 m. In GLGS: CHINA. Xizang: Zayü Xian (Tsarong Xiang). Yunnan: Fugong Xian (Lishade Xiang, Lumadeng Xiang), Gongshan



FIGURE 20. Flowering branchlets of *Gaultheria hookeri*. Photo by L. Zhou.

Xian (Bingzhongluo Xiang, Cikai Zheng, Dulongjiang Xiang), Lushui Xian (Luzhang Zheng, Mangkuan Xiang, Pianma Xiang), Tengchong Xian (Houqiao Zheng, Jietou Xiang, Mingguang Xiang), MYANMAR. Kachin: Myitkyina District (Chipwi Township, Hsawlaw Township), Putao District (Nogmung Township); Figure 21. Outside of GLGS: Guizhou, Sichuan, SE Xizang, Yunnan [Bhutan, India, Myanmar].

CHINESE NAME.—红粉白珠 hong fen bai zhu

ADDITIONAL GAOLIGONG SHAN SPECIMENS EXAMINED: CHINA.

XIZANG: ZAYÜ XIAN. 2500–2700 m, 30 Aug 1983, *S.Z. Chen* 7102 (KUN); Migyitun, 8500 ft., 28 May 1936, *F. Ludlow & G. Sherriff* 1721 (E). **Tsarong Xiang.** 3200 m, 29 Jun 1982, *QX* 7769 (KUN [2]); mtns. of Tjonatong, upper Salwin River, 14500 ft., Jun 1932, *Rock* 22335 (A, E, K); same locality, 14500 ft., Jun 1932, *Rock* 22338 (A, E, K); Wuli-la Mts., E of the Salwin River and N of Alulaka, 14000 ft., Jun 1932, *Rock* 22435 (A, E, K); same locality, 14500 ft., Jun 1932, *Rock* 22436 p.p. (A, E, K). **YUNNAN:** 9000 ft., Sep 1904, *F* 5066 (E, K); 1917, *F* 14997 (E); Jun 1917, *F* 15742 (A, E, K); 1917, *F* 15809 (A, E, K). **FUGONG XIAN.** Che-tse-lo, 4000 m, 24 Aug 1934, *Tsai* 58139 (A). Fa Mu Chang, 3200 m, 14 Jun 1979, *NE* 79-557 (KUN); Gu Qiao Da Dui, 1900–2600 m, 10 Jun 1982, *QX* 7248 (KUN [2]). **Lishadi Xiang.** Between Shibali Logging Station and Yaping Pass, ca. 4 km W of Shibali, rd from the Nujiang to Yaping Pass, E side of Gaoligong Shan, 2785 m, 2 May 2004, *GLGS* 20086 (CAS); between the Nujiang and Shibali Logging Station, ca. 6.5 km W of Shibali, rd from the Nujiang to Yaping Pass, E side of Gaoligong Shan, 2868 m, 8 May 2004, *GLGS* 20393 (CAS); same data, *GLGS* 20395 (CAS); same data, *GLGS* 20396 (CAS);

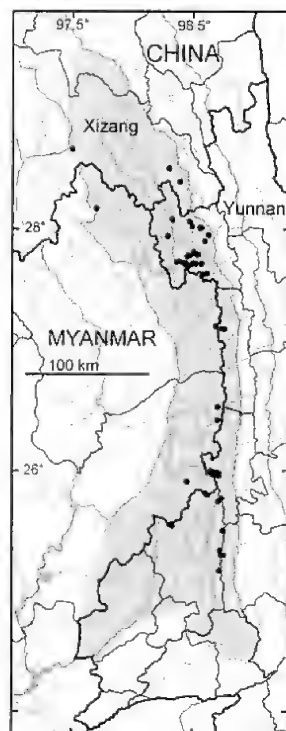


FIGURE 21. Distribution map of *Gaultheria hookeri* in the GLGS region.

Yaduo Cun, above Shibali along N side of S fork of the Yamu He, E side of Gaoligong Shan, 2900 m, 15 Aug 2005, *GLGS* 28289 (CAS). **Lumadeng Xiang**, Yaping Cun, S of Yaping Yakou in the second cirque with two small lakes in the bottom, just below border with Myanmar, E side of Gaoligong Shan, 3650 m, 17 Aug 2005, *GLGS* 28682 (CAS). **GONGSHAN XIAN**, Bai Han Luo, Yi Qi (the first district), 22 Nov 1959, *Feng* 24684 (KUN [2]); the fourth district, 3100 m, 24 May 1960, *NT* 8523 (KUN); Tong Ze to Xiong Ku, 3000 m, 6 Jun 1960, *NT* 9255 (KUN). **Bingzhongluo Xiang**, Chang Pu Tong, 3000–3200 m, 8 Sep 1940, *Feng* 7666 (KUN); in regionis temperatae ad fluvium Lu-djiang (Salween) prope Tschamutong pteridietis graminosis supra vicium Bahan, 3200–3700 m, 18 Feb 1916, *H.F. v. Handel-Mazzetti* 8953 (E); Qiu Na Tong, 3450 m, 31 May 1979, *NE* 79-295 (KUN); upper Bingzhongluo River, 2500–3450 m, 3 Aug 1979, *NE* 79-1383 (KUN); See-roo-la, 3500 m, Oct 1935, *Wang* 66779 (A); See-roo-la, Cham-pu-tung, 3000 m, Oct 1935, *Wang* 66785 (A, KUN). **Cikai Zheng**, Hei Pu Shan, 13 Oct 1940, *Feng* 8419 (KUN); track from Qi Qi toward Dulongjiang, 3000–3750 m, 15 Oct 1996, *GLGS* 7752 (E, KUN); track from Dong Shao Fang to Qiqi, 3160 m, 16 Oct 1996, *GLGS* 7811 (E, KUN); E side of divide above Dong Shao Fang Forest Station on Nan Mo Wang Shan, 2900 m, 22 Sep 1997, *GLGS* 9576 (E); E side of Gaoligong Shan, along the Danzhu He, rd from the Nuijiang at Danzhu to Myanmar border, 3300 m, 2 Jul 2000, *GLGS* 11889 (CAS, KUN); E side of Gaoligong Shan, W of Gongshan and W of Qiqi between Dongshao Fang and the pass to the Dulongjiang Valley, 3400 m, 16 Jul 2000, *GLGS* 12700 (CAS, KUN); E side of Gaoligong Shan, W of Gongshan, trail from Qiqi to Dongshao Fang and the pass to the Dulongjiang Valley, 3400 m, 17 Jul 2000, *GLGS* 12770 (CAS, KUN); E side of Gaoligong Shan, W of Gongshan, along the Pula He, trail around No. 12 Bridge, 2770 m, 2 May 2002, *GLGS* 14829 (CAS); rd from Gongshan to Kongdang, E side of Gaoligong Shan, 2830 m, 23 Sep 2002, *GLGS* 16503 (CAS, KUN); Labadi, along a branch of the Pula He, rd from Gongshan to Kongdang, E side of Gaoligong Shan, 3000 m, 29 Sep 2002, *GLGS* 16711 (CAS, KUN); same locality, 3020 m, 29 Sep 2002, *GLGS* 16725 (CAS, KUN); same locality, 2970 m, 30 Sep 2002, *GLGS* 16786 (CAS, KUN); same locality, 2970 m, 30 Sep 2002, *GLGS* 16809 (CAS, KUN); N of rd from Gongshan to Kongdang, E side of Gaoligong Shan, u-shaped valley draining into the upper reaches of the Pula He, 3350 m, 3 Oct 2002, *GLGS* 16935 (CAS, KUN); E side of Gaoligong Shan, rd from Danzhu to Myanmar border, 2700 m, 10 Nov 2004, *GLGS* 22373 (CAS); E side of Gaoligong Shan, rd from Gongshan to Kongdang, 3020 m, 11 Nov 2004, *GLGS* 22389 (CAS); same locality, 3330 m, 11 Nov 2004, *GLGS* 23014 (CAS); E side of Gaoligong Shan at Km 46, rd from Gongshan to Kongdang, 3270 m, 11 Nov 2004, *GLGS* 23029 (CAS); vicinity of Cikeluo Qiao near Km 41, rd from Gongshan to Kongdang and ca. 16.8 direct km WNW of Gongshan, E side of Gaoligong Shan, 3030 m, 21 Aug 2006, *GLGS* 33822 (CAS); vicinity of Danghatu near Km 49, rd from Gongshan to Kongdang and ca. 20.4 direct km WNW of Gongshan, E side of Gaoligong Shan, 3360 m, 21 Aug 2006, *GLGS* 33932 (CAS); Danzhu Cun, vicinity of Elong Shankou at Myanmar border, ca. 15.7 direct km WSW of Danzhu, E side of Gaoligong Shan, 3250 m, 24 Aug 2006, *GLGS* 34040 (CAS); same data, *GLGS* 34046 (CAS); same data, *GLGS* 34048 (CAS). **Dulongjiang Xiang**, Wang Nu La Ka, 2700 m, 18 Apr 1991, *GLGS* 6059 (KUN); S of the third team, 20 May 1991, *GLGS* 6926 (KUN); camping site of Zhi Zhi Zu, 2700 m, 9 May 1979, *NE* 79-76 (KUN); Dulongjiang to Gongshan, 1979, *NE* 79-618 (KUN); same data, *NE* 79-665 (KUN); Kong Mu Da Dui, 3500–3800 m, 11 Jul 1979, *NE* 79-1076 (KUN); same locality, 3500–3800 m, 17 Jul 1979, *NE* 79-1077 (KUN); same locality, *NE* 79-1099 (KUN); Salwin-Kiukiang divide, Newahlung, 3400 m, 11 Jul 1938, *Yü* 19321 (A, E, KUN); Salween-Kiukiang divide, Gemahlaka, 3700 m, 14 Oct 1938, *Yü* 20672 (KUN); Salwin-Kiukiang divide, Swangchiang, 2800 m, 5 Nov 1938, *Yü* 22964 (A, E, KUN). **LUSHUI XIAN**, From Cha Kuo to 3793 location, 3000–3300 m, 3 Aug 1978, *BE* 1742 (KUN); Yao Jia Ping, 3000 m, 13 Jul 1960, *NT* 10414 (KUN); same data, *NT Team* 10416 (KUN). **Luzhang Zheng**, Pianma Yakou, pass between Lushui and Pianma, crest of Gaoligong Shan, 3250 m, 15 Oct 2002, *GLGS* 15954 (CAS, KUN); area above Yaojiaping Forest Station, Sanjiang River, E side of Gaoligong Shan, 2737 m, 18 May 2005, *GLGS* 24458 (CAS); vicinity of Yaojiaping Forest Station between Lushui and Pianma, E side of Gaoligong Shan, 2720 m, 19 May 2005, *GLGS* 24485 (CAS); just below Fengxue Yakou (the pass between Lushui and Pianma), between Km 54 and 58, E side of Gaoligong Shan, 3125 m, 19 May 2005, *GLGS* 24520 (CAS); same data, *GLGS* 24539 (CAS); same data, *GLGS* 24542 (CAS). **Mangkuan Xiang**, Bai Hua Ling, 8 May 1997, *Dao et al.* 9435 (KUN [2]); Baihualing, Zhan Gong Fang, 3100 m, 1 Sep 1995, *X.C. Shi* 682 (KUN [2]). **Pianma Xiang**, Hpimaw Hill, 9000–10000 ft., 30 May 1919, *R.J. Farrer* 990 (E); E slope of Pianma You Kou, 2900 m, 27 Oct 1996, *GLGS* 8132 (KUN); same data, *GLGS* 8133 (KUN); W slope of Irrawaddy-Salween Watershed, rd to Pian Ma, ca.

10–20 km E of Pian Ma, 2800 m, 25 Oct 1996, *GLGS* 8285 (E, KUN); Pian Ma Ya Kou, summit of rd from Liuku to Pian Ma, 3140 m, 4 Oct 1997, *GLGS* 9960 (E, KUN); vicinity of Pianma Pass, rd from Lushui to Pianma, W side of Gaoligong Shan, 3080 m, 11 May 2005, *GLGS* 22690 (CAS); same locality, 14 May 2005, *GLGS* 22883 (CAS); vicinity of Km 58, rd from Lushui to Pianma, W side of Gaoligong Shan, 2810 m, 14 May 2005, *GLGS* 22908 (CAS); vicinity of Km 62, rd from Lushui to Pianma, W side of Gaoligong Shan, 2790 m, 17 May 2005, *GLGS* 23306 (CAS); same locality, 2760 m, 17 May 2005, *GLGS* 23318 (CAS); vicinity of Feng Xue Yakou (Windy and Snowy Pass), rd from Lushui to Pianma, W side of Gaoligong Shan, 3127 m, 11 May 2005, *GLGS* 23946 (CAS); upper slopes of the Pianma River, ca. 10 km E of Pianma, W side of Gaoligong Shan, 2510 m, 16 May 2005, *GLGS* 24247 (CAS). **TENGCHONG XIAN.** Shweli-Salwin divide, 10000 ft., Aug 1912, *F* 9003 (A, E, K); Shweli-Salwin divide, 9000–10000 ft., Aug 1913, *F* 11778 (A, E, K); Shweli-Salwin divide, 13000 ft., Sep 1917, *F* 14966 (E); Jang-tzaw Shan, Shweli-Salwin divide, 9000 ft., Jul 1919, *F* 18360 (E, K); top of Salwin-Shweli divide, 1922, *J.W. & C.J. Gregory B. G-3* (BM). **Houqiao Zheng (Guyong Zheng).** Ji Zhao Shan (Chicken Feet Mtn.), 3500–3640 m, 25 May 1964, *Wu* 6888 (KUN); Dan Zha, Jian Gao Shan, Xia Si He, 2400 m, 1 Jun 1964, *Wu* 6955 (KUN). **Jietou Xiang.** Datang Cun, vicinity of Daogou Yilinggan, NNE of Datang, W side of Gaoligong Shan, 2900 m, 16 May 2006, *GLGS* 30125 (CAS). **Mingguang Xiang.** Zizhi Cun, near ridgetop along trail parallel with Myanmar border to W of border crossing at Baduolin Yakou (the pass into Myanmar at border marker 8), Jiangao Shan, ca. 10 direct km NE of Zizhi, W side of Gaoligong Shan, 3000–3050 m, 19 May 2006, *GLGS* 29152 (CAS); Zizhi Cun, ca. 9.5 direct km NE of Zizhi, rd to Baduolin Yakou (the pass into Myanmar at border marker 8), Jiangao Shan, W side of Gaoligong Shan, 2750–2850 m, 19 May 2006, *GLGS* 29222 (CAS); same data, *GLGS* 29243 (CAS). **MYANMAR. KACHIN: MYITKYINA DISTRICT. Chipwi Township.** N'maikha-Salwin divide, 9000–10000 ft., Jun 1931, *F* 29704 (E); Htaungaw, valley of Maung-chuang, Jalu country, 9000–10000 ft., 1914, *KW* 1617 (E); Hsaugaw, valley of Naung-chaung, Laohi County, 6 Mar 1914, *KW* 1627 (E). **Hsawlaw Township.** Chewchi Pass, 11800 ft., 3 May 1920, *R.J. Farrer* 1679 (E). **PUTAO DISTRICT. Nongmung Township.** Adung Valley, 8000 ft., 27 May 1931, *KW* 9556 (A); same locality, 11000 ft., 31 May 1931, *KW* 9570 (A); same locality, 8000 ft., 1 Jun 1931, *KW* 9573 p.p. (A).

11. *Gaultheria hypochlora* Airy Shaw, Bull. Misc. Inform. Kew 1940:324. 1941. TYPE.—INDIA. Assam: Delei Valley, 3000 m, 31 May 1928, *F. Kingdon Ward* 8266 (holotype: K!).

Shrublets 3–30 cm tall, prostrate to decumbent. Branchlets elongate, terete, brown- to ferrugineous-ascending-villous or slightly -uncinate-setulose and occasionally white-puberulent. Petiole 0.5–1.5 mm, abaxially glabrous or sparsely setulose, adaxially glabrous or white-puberulent; larger leaf blades oblanceolate, suborbicular, or rarely elliptic, 8–15 × 2.8–8.5 mm, gradually smaller and often narrower along stems toward both ends of each year's growth, 1.2–3.6 × as long as wide, subcoriaceous to coriaceous, abaxially dull light to often whitish green, or light brown, with a narrow glossy edge and sparsely setulose at least along midvein on at least some leaves, adaxially ± glossy green to brown and glabrous or white-puberulent proximally along midvein, midvein abaxially raised to prominent and adaxially sulcate to planar, secondary veins distinct or rarely obscure, (when visible) 1–3 on each side of midvein, tertiary veins distinct or rarely obscure, base cuneate to subrounded, margin serrulate, with 8–15 setulose-tipped teeth per side, revolute, apex acute, rounded, or emarginate. Inflorescences axillary, 5.5–8 mm, 1-flowered; bracts absent. Pedicel 1.5–4 mm, glabrous or occasionally setulose; bracteoles 2, apical, ovate, suborbicular, or occasionally elliptic, not or occasionally keeled, 1.2–3 × 1.5–2.3 mm, persistent, glabrous or occasionally setulose, margin entire, apex acute to rounded. Calyx 3–4.5 mm; lobes (4)5, deltoid to narrowly ovate-deltoid, 1.8–2.4 × 1.5–2.1 mm, mostly overlapping at base, outside glabrous, inside glabrous or pubescent, margin usually ciliolate apically or rarely entire throughout, apex acute to obtuse. Corolla white to pink, campanulate, 3.5–4 × 4–6 mm, glabrous on both sides; lobes (4)5, deltoid to deltoid-oblong, 1.5–2.5 mm. Stamens (6–)10; filaments 1–1.3 mm, gradually dilated medially from apex, glabrous; anthers 0.6–0.8 mm, 2–4-awned; awns 0.3–0.4 mm. Ovary glabrous; style 1.5–2

mm. Calyx at fruiting blue, fleshy; lobes incurved, not or narrowly pale-edged. Capsule 7–9 mm in diam., glabrous.

Included under this species are all specimens of *Gaultheria* series *Trichophyllae* in GLGS with blue fruit, setulose-tipped teeth on the leaf margin, and deltoid or narrowly ovate-deltoid calyx lobes. As noted by Fang and Stevens (2005), *G. hypochlora* is often difficult to distinguish from *G. sinensis*. In his key to the species of series *Trichophyllae* known at the time of publication, Airy Shaw (1941) delimited *G. hypochlora* from *G. sinensis* by: leaves more or less chartaceous-coriaceous, obovate, cuneate at base, apex rounded, pallid below, green above, to 15 mm × 8 mm, and nerves below slightly prominent (versus leaves rigid and thick-coriaceous, elliptic-oblong to obovate, much less conspicuously discolored, to 17 × 5 mm, acute at both ends, and nerves below obscure). Fang and Stevens (2005) distinguished *G. hypochlora* from other species of series *Trichophyllae* in their key solely by leaf blade shape and size (obovate or oblong, less than two times as long as wide, 6–8 mm wide, apex obtuse to rounded, versus usually elliptic, elliptic-oblong, or linear, more than 2 × as long as wide, 1–7 mm wide, apex acute, obtuse, or acuminate).

Although these characters work reasonably well to place many of our specimens in one or the other species, from our examination of material both within and outside the GLGS it is clear that there are many narrow-leaved specimens (i.e., blade more than 2 × as long as wide) with strongly bicolorous leaf surfaces and other features of the leaf blade that would seem to most closely match *G. hypochlora* rather than *G. sinensis* (e.g., GLGS 16918, 31158, 32235; T.T. Yü 20049). Of these specimens, those in flower have a calyx with narrowly deltoid lobes, like those of all other *G. hypochlora* and unlike those of *G. sinensis*, in which the calyx lobes are broadly ovate-deltoid. We have included all such specimens under *G. hypochlora*, basing the main difference between the two species on calyx shape. In doing so, we have necessarily broadened the definition of *G. hypochlora* to include more narrow-leaved specimens. To the west of the GLGS, the leaves of some plants of what appear to be *G. hypochlora* become even narrower (e.g., *D. Long et al.* 742, Sikkim, India (E); *F. Ludlow et al.* 3733, Pachakshiri District, Xizang Province, China (E)), and it might be questioned whether these plants are really conspecific with those having the typical obovate to suborbicular leaves common in the GLGS and elsewhere in China. More collections and study of especially flowering material of these two species from across their ranges would help to clarify the taxonomy of this challenging group.

See also comments under *Gaultheria sinensis*.

ILLUSTRATIONS.— The illustrations of *Gaultheria sinensis* by R.C. Fang, *Fl. Reipubl. Popularis Sin.* 57(3):64 t. 19(6–8). 1991 and by G.H. Zhu & L.B. Zhang, eds. *Fl. China* Ill. 14: t. 666(6–8) are both the same as that of *G. hypochlora* by R.C. Fang, *Gaultheria* in L.K. Fu & T. Hong, eds. *Higher Pl. China* 5:696 t. 1121. 2003 (the latter treats *G. sinensis* as a synonym of *G. hypochlora*). We cannot discern which of the two species is illustrated in these works, because diagnostic features used in our treatment to distinguish them are not clearly depicted. The illustration of the fruit in the figures appears not to be that of *Gaultheria*.

PHENOLOGY.— Fl. Apr–Jul, fr. Jul–Oct.

DISTRIBUTION AND HABITAT.— Coniferous forests, thickets, meadows, grassy slopes, rocky places; 2500–4100 m. In GLGS: CHINA. Xizang: Zayü Xian (Tsarong Xiang). Yunnan: Fugong Xian (Lishadi Xiang, Lumadeng Xiang), Gongshan Xian (Bingzhongluo Xiang, Cikai Zheng, Dulongjiang Xiang), MYANMAR. Kachin: Myitkyina District (Hsawlaw Township, Waingmaw Township); Figure 22. Outside of GLGS: Sichuan, Xizang, Yunnan [Bhutan, India, Myanmar].

CHINESE NAME.— 绿背白珠 *lu bei bai zhu*

GAOLIGONG SHAN SPECIMENS EXAMINED: CHINA. XIZANG: ZAYÜ XIAN. Prope fines Tibeto-

Birmanicas inter fluvios Ludiang (Salween) et Djiou-djiang (Irrawadi or sup.), in jugi Tschiangschel, 3500–3800 m, 5 Jul 1916, *H.F. v. Handel-Mazzetti* 9382 (A). **Tsarong Xiang**. Mt. Wuli-La, E of the Salwin River and N of Alulaka, 13500 ft., Jun 1932, *Rock* 22407 (A, E, P). **YUNNAN: FUGONG XIAN. Lishadi Xiang**. Vicinity of Yaping Pass near Myanmar border, E side of Gaoligong Shan, 3620 m, 5 May 2004, *GLGS* 20970 (CAS); Yaduo Cun, vicinity of Rimagudi, N side of N fork of Yamu He above Shibali, rd to Myanmar border, E side of Gaoligong Shan, 3560 m, 12 Aug 2005, *GLGS* 27029 (CAS); Yaduo Cun, vicinity of Luodigoulu, N side of N fork of Yamu He, E side of Gaoligong Shan, 2520 m, 16 Aug 2005, *GLGS* 28441 (CAS); Yaduo Cun, NE of Yaping Yakou at Myanmar border, N side of N fork of Yamu He, E side of Gaoligong Shan, 3840 m, 17 Aug 2005, *GLGS* 28628 (CAS); same data, *GLGS* 28629 (CAS). **Lumadeng Xiang**. Yaping Cun, SE Amero Pass along the ridge that forms the border between China and Myanmar, E side of Gaoligong Shan, 3460 m, 13 Aug 2005, *GLGS* 27221 (CAS). **GONGSHAN XIAN. Bingzhongluo Xiang**. Chang Pu Tong, 3800 m, 11 Sep 1940, *Feng* 7804 (KUN); along N side of Nianwaluo He, trail from Fucui to Chukuai Lake, ca. 13.2 direct km WSW of Bingzhongluo, E side of Gaoligong Shan, 3470 m, 17 Aug 2006, *GLGS* 31158 (CAS); ca. 3.4 direct km S of Gawagapu Mtn. and ca. 15.8 direct km WSW of Bingzhongluo in next basin E of Chukuai lake, E side of Gaoligong Shan, 3710 m, 30 Aug 2006, *GLGS* 31683; Dong Ta, 3600 m, 25 Jun 1982, *QX* 7580 (KUN); Champutong, Sijitong, 3000 m, Oct 1935, *Wang* 67196 (A). **Cikai Zheng**. Hei Pu Shan, 9 Oct 1940, *Feng* 8313 (KUN); rd from Gongshan to Kongdang, E side of Gaoligong Shan, 3340 m, 1 Oct 2002, *GLGS* 16817 (CAS, KUN); N of rd from Gongshan to Kongdang, E side of Gaoligong Shan, u-shaped valley draining into the upper reaches of the Pula He, 3350 m, 3 Oct 2002, *GLGS* 16918 (CAS, KUN [2]); same locality, 3429 m, 3 Oct 2002, *GLGS* 16950 (CAS, KUN); Heipu Pass, rd from Gongshan to Dulongjiang Valley, E side of Gaoligong Shan, 3490 m, 12 Aug 2006, *GLGS* 32036 (CAS); same data, *GLGS* 32053 (CAS [2]); same data, *GLGS* 32060 (CAS); Yipsaka Lake, 2.4 direct km SE of Heipu Pass tunnel on new rd from Gongshan to Dulongjiang valley, E side of Gaoligong Shan, 3560 m, 12 Aug 2006, *GLGS* 32074 (CAS); same data, *GLGS* 32080 (CAS); ca. 1.2 direct km SSE of Heipu Pass tunnel on new rd from Gongshan to Dulongjiang Valley, E side of Gaoligong Shan, 3350 m, 13 Aug 2006, *GLGS* 32127 (CAS); same data, *GLGS* 32150A (CAS); near Yipsaka Lake, 2.1 direct km SSE of Heipu Pass tunnel on new rd from Gongshan to Dulongjiang Valley, E side of Gaoligong Shan, 3450 m, 13 Aug 2006, *GLGS* 32235 (CAS); vicinity of Danghatu near Km 49 on rd from Gongshan to Kongdang and ca. 20.4 direct km WNW of Gongshan, E side of Gaoligong Shan, 3360 m, 21 Aug 2006, *GLGS* 33929 (CAS); Danzhu Cun, along the Damawadi He (N branch of W-most origin of the Danzhu He) ca. 0.5 km E of Myanmar border and ca. 15.5 direct km WSW of Danzhu, E side of Gaoligong Shan, 3220 m, 24 Aug 2006, *GLGS* 34106 (CAS); Qiqi trail to 12th bridge, 2400–2600 m, 3 Jun 2006, *Lu* 40 (CAS). **Dulongjiang Xiang**. Xishaofang, 3400 m, 15 Oct 1996, *GLGS* 7758 (KUN); N side of pass above tunnel on rd between Gongshan and Kongdang, W side of Gaoligong Shan, 3530 m, 2 Oct 2002, *GLGS* 16876 (CAS, KUN); E side of pass of rd from Gongshan to Kongdang, W side of Gaoligong Shan near crest of range, 3670 m, 5 Oct 2002, *GLGS* 17007 p.p. (CAS, KUN); W side of pass on rd from Gongshan to Kongdang, E side of Gaoligong Shan near crest of range, 3750 m, 5 Oct 2002, *GLGS* 17032 (CAS, KUN); Song Du to Dong Shao Fang, 2600 m, 22 Jul 1982, *QX* 8345 (KUN); Taron-taru divide, Ahtehmai, 2500 m, 29 Aug 1938, *Yü* 20049 (A, E, KUN); Tarulaka, 3000 m, 3 Sep 1938, *Yü* 20058 (KUN); Salwin-Kiukiang divide, Lunguailaka, 3600 m, 14 Sep 1938, *Yü* 20262 (A, E, KUN); Tsukuai, 3600 m, 16 Oct 1938, *Yü* 20709 (A, E, KUN). **MYANMAR. KACHIN: MYITKYINA DISTRICT. Hsawlaw Township**. Chimili Woods, 10800 ft., 4 Aug 1919, *R.J. Farrer* 1191 (E); Chewchi Pass, 11000 ft., 2 Jul 1920, *R.J. Farrer* 1676 (E); same locality, 12500 ft., 18 Jul 1920, *R.J. Farrer* 1737 (E); ridge above Laktang, 8000–11000 ft., 25 May 1962, *KW* 3062 (E). **Waingmaw Township**. Base of Seinghku, 10000 ft., 6 Apr 1924, *KW* 6845 (K [2]).

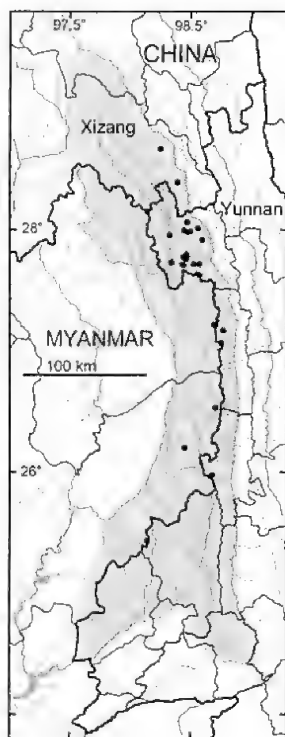


FIGURE 22. Distribution map of *Gaultheria hypochlora* in the GLGS region.

12. *Gaultheria leucocarpa* Blume, Bijdr. Fl. Ned. Ind., 856. 1826. *Brossaea leucocarpa* (Blume) O. Kuntze, Revis. Gen. Pl. 2:388. 1891. TYPE.—INDONESIA. Java. C.L. Blume s.n. (lectotype, designated by Sleumer (1957): L Herb. Lugd. Bat., No. 903.13-217 (Barcode No. 0007112) [on-line image!]; isolectotype: NY [on-line image!]; possible isolectotype: K!).

Shrubs 0.4–1.5 m tall, arching to scandent, with strong wintergreen odor. Branchlets elongate, terete to slightly flattened, glabrous or densely setose-glandular-hirsute and white-puberulent. Petiole 3–5 mm, glabrous or adaxially white-lanulate, rarely setose-hirsute; leaf blade lanceolate, 5.5–11 × 2.8–4.1 cm, usually smaller distally along stems, (1.7–)2.2–3.2 × as long as wide, thickly chartaceous to subcoriaceous, abaxially green to brown and glabrous and eglandular or glandular-setulose, adaxially glabrous or proximally white-villulose on midvein or rarely glandular-setulose, midvein abaxially prominent and adaxially slightly sulcate, secondary veins 3–5 on each side of midvein, arising along midvein with proximal veins becoming faint or anastomosing before reaching apex, abaxially raised, adaxially planar to impressed, tertiary veins abaxially raised and adaxially planar to impressed, base cordate, margin planar to slightly revolute, regularly serrulate, with 30–65 teeth per side, teeth rarely glandular-setose, apex long-acuminate. Inflorescences axillary and terminal, open racemes or occasionally panicles, 1.5–9 cm, 1–11-flowered; rachis slender, glabrous or rarely glandular-setulose-hirsute and white-puberulent; bracts deltoid to linear-deltoid, slightly keeled, 1.5–5 × 1–1.2 mm, persistent, glabrous, margin ciliate, apex acute. Pedicel 4–8 mm, glabrous; bracteoles apical, 1.1–1.7 × 1.2–1.7 mm, base cordate, apex acute-acuminate, otherwise similar to bracts. Calyx 2.5–3.5 mm; lobes 5, broadly deltoid-ovate, 1.6–2 × 1.8–2 mm, glabrous, margin ciliate, apex acute. Corolla white to green, campanulate, 3.5–5 × 3.5–5.5 mm, glabrous; lobes 5, deltoid, 1.3–2 mm. Stamens 10; filaments 1.2–1.5 mm, gradually dilated medially from apex, glabrous; anthers 0.9–1.4 mm, awns 0.3–0.4 mm. Ovary densely white-pilulose; style 2–3.5 mm, glabrous. Calyx at fruiting dark purple to black, fleshy; lobes ± incurved, not pale-edged. Capsule 4–7 mm in diam., sericeous.

The GLGS specimens of *Gaultheria leucocarpa* can be placed into two groups corresponding to glabrous versus pubescent branchlets and leaves. Both groups have a pubescent ovary and dark purple to black fruits, thus delimiting them from other varieties of the species. Such variants were recognized in the Flora of China treatment of *Gaultheria* (Fang and Stevens 2005) as vars. *yunnanensis* and *crenulata* respectively (the only other variety of *G. leucocarpa* recognized in the Flora of

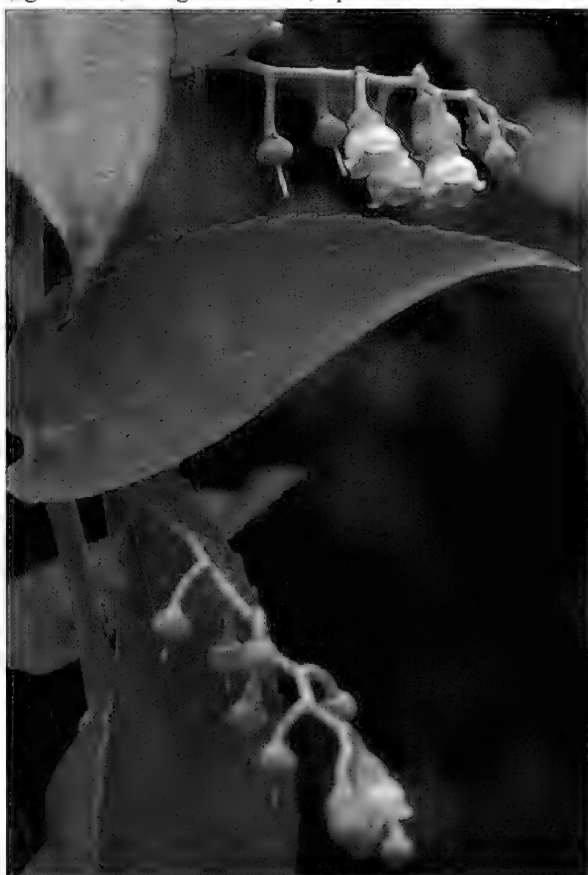


FIGURE 23. Flowering branchlet of *Gaultheria leucocarpa*. Photo by L. Zhou.

China is var. *psilocarpa* (Copeland) R.C. Fang from Taiwan and the Philippines, with a glabrous ovary). Neither of these names, however, are correct. *Gaultheria l.* variety *hirsuta* [described originally as a variety of *G. yunnanensis*] appears to be taxonomically identical to var. *crenulata*, because the pubescence on the type specimen (1868, *D.J. Anderson s.n.*; K) matches that described for var. *hirsuta*. Although type material of the latter was not available to us, the taxonomic equivalence of these two varieties is confirmed by Fang and Stevens (2005), who placed *G. l.* var. *hirsuta* as a synonym of *G. l.* var. *crenulata*. Yet, the varietal epithet *hirsuta* was published four years earlier (1977) than the varietal epithet *crenulata* (1981).

As for the glabrous variant, Fang and Stevens (2005) placed *Gaultheria leucocarpa* var. *pingbienensis* in synonymy of *G. l.* var. *yunnanensis*, but the varietal epithet *pingbienensis* predates the varietal epithet *yunnanensis* by 18 years. Despite an intensive search of the KUN herbarium, we were unable to locate the type of *G. l.* var. *pingbienensis*, and we have not seen any other type material of this taxon. Thus we must rely on the treatment of Fang and Stevens (2005) as the basis for synonymy of these two taxa, with the caveat that *G. l.* var. *pingbienensis* was originally described as having affinity with *G. l.* var. *crenulata*, differing in only leaf shape characters — implying that, like *G. l.* var. *crenulata*, the branchlets are setose-glandular-hirsute.

Another name listed in synonymy of *Gaultheria leucocarpa* var. *yunnanensis* is *Vaccinium yunnanense* var. *franchetianum* H. Lévillé, but this is a *nomen nudum*.

SELECTED ILLUSTRATIONS.— R.C. Fang, *Fl. Reipubl. Popularis Sin.* 57(3):62 t. 18(1–8). 1991; G.H. Zhu & L.B. Zhang, eds. *Fl. China* Ill. 14: t. 662(1–8). 2006.

PHOTOGRAPHIC IMAGES.— Figures 23–24.

PHENOLOGY.— Fl. May–Aug, fr. Aug–May.

DISTRIBUTION AND HABITAT.— Subtropical evergreen broadleaf forests, secondary forests, coniferous forests, thickets on open slopes; 1500–2400(–3000) m. In GLGS: CHINA. Yunnan:



FIGURE 24. Fruiting branchlets of *Gaultheria leucocarpa* with immature fruit. Photo by L. Zhou.

Longling Xian, Tengchong Xian (Houqiao Zheng, Qushi Xiang, Shangyun Xiang, Yunhua Xiang), MYANMAR. Kachin: Myitkyina District (Chipwi Township); Figure 25. Outside of GLGS: Fujian, Guangdong, Guangxi, Guizhou, Hubei, Hunan, Jiangxi, Sichuan, Taiwan, Yunnan [Cambodia, Indonesia, Laos, Malaysia, Philippines, Thailand, Vietnam].

CHINESE NAME.—白果白珠 *bai guo bai zhu*.

1. Branchlets and leaves glabrous 14a. var. *pingbienensis*

1. Branchlets and leaves setose-glandular-hirsute and white-puberulent 14b. var. *hirsuta*

12a. *Gaultheria leucocarpa* Blume var. *pingbienensis* C.Y. Wu ex T.Z. Xu, Acta Bot. Yunnan. 3:429. 1981. TYPE.—CHINA. Yunnan: Pingbian Xian, K.M. Feng 4827 (holotype: KUN!).

Gaultheria laxiflora Diels, Bot. Jahrb. Syst. 29:515. 1900. TYPE.—CHINA. Sichuan: Nan ch'uan, Feng hsiang t'ang, A. von Rosthorn 346 (syntype: B, destroyed); Nan ch'uan, Ch'ien ts'un kou, A. von Rosthorn 624 (syntype: B, destroyed).

Pieris fortunatii H. Lévêillé, Bull. Soc. Bot. France 54:369. 1907. TYPE.—CHINA. Guizhou: no locality or collector indicated, 666 (holotype: P).

Pieris vaccinium H. Lévêillé, Rep. Spec. Nov. Regni Veg. 9:448. 1911. TYPE.—CHINA. Guizhou: Mont de Lou Tsong-Koan, 12 Jun 1897, E.M. Bodinier 1659 (syntype: P); Gan-Pin, 28 Jul 1898, L. Martin s.n. (syntype: P).

Embelia vaniotii H. Lévêillé, Fl. Kouy-Tchéou, 285. 1914–1915. TYPE.—Mount Tong Tscheou, June 1912, J. Ziguizo 3051 (holotype: P).

Gaultheria leucocarpa Blume var. *yunnanensis* (Franchet) T.Z. Xu & R.C.

Fang, Novon 9:166. 1999. Basionym: *Vaccinium yunnanense* Franchet, J. Bot. (Morot) 9:368. 1895.

Gaultheria yunnanensis (Franchet) Rehder, J. Arnold Arbor. 15:282. 1934. TYPE.—CHINA. Yunnan: Tchen-fong-chan [Cheng-feng-shan], P.J.M. Delavay 3069 (holotype: P; isotype: L [on-line image!]).

Branchlets and leaves glabrous.

SELECTED ILLUSTRATIONS.—R.C. Fang, Fl. Reipubl. Popularis Sin. 57(3):62 t. 18(5–8). 1991; G.H. Zhu & L.B. Zhang, eds. Fl. China Ill. 14: t. 662(5–8). 2006.

PHENOLOGY.—Fl. May–Aug, fr. Aug–May.

DISTRIBUTION AND HABITAT.—Subtropical evergreen broadleaf forests, secondary forests, coniferous forests, thickets on open slopes; 1500–2400(–3000) m. In GLGS: CHINA. Yunnan: Longling Xian, Tengchong Xian (Houqiao Zheng, Qushi Xiang, Shangyun Xiang, Yunhua Xiang), MYANMAR. Kachin: Myitkyina District (Chipwi Township); Figure 25. Outside of GLGS: Fujian, Guangdong, Guangxi, Guizhou, Hubei, Hunan, Jiangxi, Sichuan, Taiwan, Yunnan [Cambodia, Laos, Thailand, Vietnam].

CHINESE NAME.—无毛白果白珠 (新拟) *wu mao bai guo bai zhu*.

GAOLIGONG SHAN SPECIMENS EXAMINED: CHINA. YUNNAN: **LOGLING XIAN.** Yunlong Shan, Fulong Tan, 1510 m, 30 Nov 1958, J. Chen 679 (KUN). **TENGCHONG XIAN.** Divide between the Shweli and Tengyueh valleys, 6000 ft., May 1912, F 7965 (E, K); W flank of the Shweli-Salwin divide, 10000 ft., Aug 1912, F 9061 (A, E, K); hills N of Tengyueh, 8000 ft., Nov 1912, F 9298 (E, K). **Houqiao Zheng (Guyong Zheng).** From Houqiao to Gaoligong Shan pass, 2400 m, 18 May 1964, Wu 6608 (KUN). **Qushi Xiang.** Gongping, N of Tengchong between Tengchong and Qushi, 1760 m, 26 Oct 1998, GLGS 10983 (CAS,

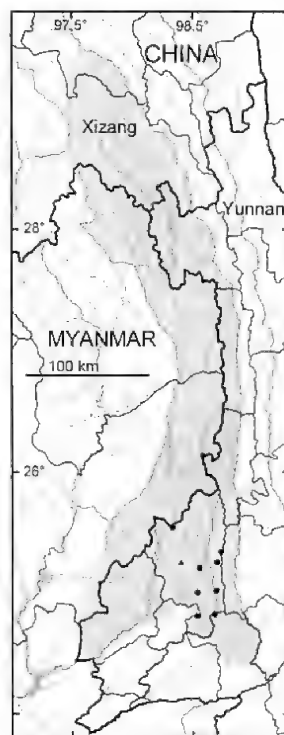


FIGURE 25. Distribution map of *Gaultheria leucocarpa* in the GLGS region. Dots = var. *pingbienensis*; triangle = var. *hirsuta*.

KUN). **Shangyun Xiang.** Chuanglong Cun, vicinity of Wangduo Village, W side of Gaoligong Shan, old rd from Baoshan to Tengchong via Dahaoping, 1540 m, 31 Aug 2003, *GLGS 18202* (CAS). **Yunhua Xiang.** Chao Yun Shan to Hong Mu Shu, 2000 m, 13 Oct 1965, *J.Z. Zhao 8* (KUN). **MYANMAR. KACHIN: MYITKYINA DISTRICT. Chipwi Township.** Kang-fang, N Burma, 6000 ft., 4 Jan 1939, *KW 188* (A. BM).

12b. *Gaultheria leucocarpa* var. *hirsuta* (D. Fang & N.K. Liang) T.Z. Xu, *Acta Bot. Yunnan.* 3:428. 1981. Basionym: *Gaultheria yunnanensis* (Franchet) Rehder var. *hirsuta* D. Fang & N.K. Liang, *Acta Phytotax. Sin.* 15(2):112. 1977. TYPE.—CHINA. Guangxi: Guiping Xian, Zijin, Yunnan, *N.K. Liang & D. Fang 10748* (holotype: Medical Institute of Guangxi; isotypes: PE, SZ).

Gaultheria leucocarpa Blume var. *crenulata* (Kurz) T.Z. Xu, *Acta Bot. Yunnan.* 3:429. 1981. Basionym: *Gaultheria crenulata* Kurz, *J. Bot.* 11:195. 1873. TYPE.—CHINA. Yunnan: [Tengchong Xian], Hotha [Tengchong], 15 August 1868, *D.J. Anderson* (holotype: CAL; isotype: K!).

Branchlets and leaves setose-glandular-hirsute and white-puberulent.

SELECTED ILLUSTRATIONS.—R.C. Fang, *Fl. Reipubl. Popularis Sin.* 57(3):62 t. 18(1–4). 1991; G.H. Zhu & L.B. Zhang, eds. *Fl. China* Ill. 14: t. 662(1–4). 2006.

PHENOLOGY.—Fl. Aug.

DISTRIBUTION AND HABITAT.—In GLGS: CHINA. Yunnan: Tengchong Xian; Figure 25. Outside of GLGS: Guangxi (Guiping Xian).

CHINESE NAME.—硬毛白珠 *ying mao bai zhu*

13. *Gaultheria nivea* (J. Anthony) Airy Shaw, *Bull. Misc. Inform. Kew* 1940:326. 1941. Basionym: *Gaultheria sinensis* var. *nivea* J. Anthony, *Notes Roy. Bot. Gard. Edinburgh* 18:20. 1933. TYPE.—CHINA. Xizang: [Zayü Xian], Tsarong [Xiang], Salwin-Kiu Chiang divide [Gaoligong Shan], 28°40'N, 98°15'E, July 1919, *G. Forrest 19269* (holotype: E!; isotypes: A!, K!).

Shrublets 3–10 cm tall, prostrate. Branchlets elongate, terete, sparsely to densely light brown-to ferruginous-uncinate-setulose and sparsely to densely white-puberulent. Petiole 0.4–1 mm, abaxially glabrous, adaxially white-puberulent; leaf blade elliptic, 5.5–8 × 1.8–3 mm, gradually smaller along stems toward both ends of each year's growth, 2.1–3.5 × as long as wide, coriaceous, abaxially dull light green to light brown with glossy edge, adaxially glossy green or brown, both surfaces glabrous except puberulent on midvein adaxially toward base, midvein abaxially prominent and adaxially sulcate, secondary and tertiary veins obscure, base cuneate to subcuneate, margin serrate, with 5–10 setulose-tipped teeth per side, planar to slightly revolute, apex acute to obtuse. Inflorescences axillary, 5–6.5 mm, 1-flowered; bracts absent. Pedicel 1.5–2 mm, glabrous; bracteoles 2, apical, broadly ovate, not keeled, 1.2–1.8 × 1.2–1.8 mm, persistent, glabrous, margin entire, apex broadly obtuse. Calyx 2.5–3 mm; lobes 5, ovate-deltoid, 2.5–2.7 × 1.5–1.8 mm, not overlapping at base, glabrous, margin entire, apex acuminate. Corolla white, campanulate, 3–3.5 × 4–5.5 mm, glabrous on both sides; lobes 5, deltoid-oblong, 1.2–1.5 mm. Stamens 10; filaments 0.8–0.9 mm, ± abruptly constricted medially from apex, glabrous; anthers 0.7–0.8 mm, 4-awned; awns 0.5–0.7 mm. Ovary glabrous; style ca. 1.5 mm, glabrous. Calyx at fruiting white, fleshy; lobes incurved to erect, narrowly pale-edged. Capsule 4–6 mm in diam., glabrous.

In the treatment of *Gaultheria* for the *Flora of China*, Fang and Stevens (2005) considered this taxon a variety of *G. sinensis*, whereas Airy Shaw (1941) treated it at the species level. We follow Airy Shaw's treatment, based on the narrower leaf blades (1.8–3 mm wide) with glabrous abaxial surfaces, calyx lobes 2.5–2.7 × 1.5–1.8 mm, and white fruit, all of which easily delimit it from

G. sinensis, which has leaf blades 3–7 mm wide with sparsely setulose abaxial surfaces along midvein on at least some leaves, calyx lobes $1.5\text{--}2.3 \times 1.8\text{--}2.5$ mm, and blue fruit. All these characters confer a closer resemblance of *G. nivea* to *G. cardiosepala*, *G. dolichopoda*, and *G. thymifolia* than to *G. sinensis*. During the summer 2006 GLGS expedition to the area of Chukuai Lake, both *G. nivea* and *G. thymifolia* were found growing in the same lake basin. Both of these collections were in fruit, and it would be desirable for flowering collections to be made of these and other populations in the area to better assess the distinctness of these two species.

ILLUSTRATIONS.— None known to us.

PHENOLOGY.— Fl. Jul, fr. Aug–Sep.

DISTRIBUTION AND HABITAT.— Alpine meadows, open ledges of cliffs, humus-covered boulders, stony slopes, among mosses; 3700–3800 m. In GLGS: CHINA. Xizang: Zayü Xian (Tsarong Xiang). Yunnan: Gongshan Xian (Bingzhongluo Xiang); Figure 26. Outside of GLGS: Yunnan.

CHINESE NAME.— 白果华白珠 *bai guo hua bai zhu*

ADDITIONAL GAOLIGONG SHAN SPECIMEN EXAMINED: CHINA.

YUNNAN: GONGSHAN XIAN. Bingzhongluo Xiang. Ca. 3 direct km SSW of Gawagapu Mtn. and ca. 16 direct km WSW of Bingzhongluo in the basin E of Chukuai Lake, E side of Gaoligong Shan, 3770 m, 29 Aug 2006, GLGS 31581 (CAS).

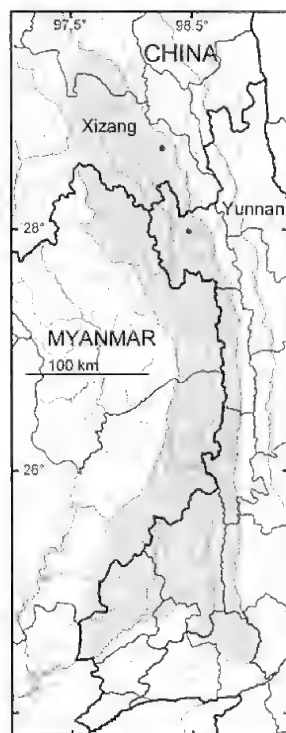


FIGURE 26. Distribution map of *Gaultheria nivea* in the GLGS region.

14. *Gaultheria notabilis* J. Anthony, Notes Roy. Bot. Gard. Edinburgh 18:18, 1933. TYPE.— CHINA, Yunnan: [Tengchong Xian], hills northwest of Tengyueh [Gaoligong Shan], $25^{\circ}25'N$, $98^{\circ}30'E$, 8000 ft., June 1925, *G. Forrest* 26722 (holotype: E!; isotype: K!).

Shrubs 0.3–0.4 m tall. Branchlets elongate, terete, densely ferrugineous-villous-setose and white-puberulent. Petiole 2–2.5 mm, villous-setose; leaf blade ovate, $1.9\text{--}3.4 \times 1.2\text{--}1.7$ cm, $1.6\text{--}2 \times$ as long as wide, chartaceous to subcoriaceous, abaxially light brown- and ferrugineous-villous-setose, adaxially glabrous, midvein abaxially prominent and adaxially sulcate, secondary veins 2 on each side of midvein, arising along midvein near base and extending to apex, abaxially raised, adaxially impressed to planar, tertiary veins abaxially raised and adaxially impressed to planar, base rounded, subtruncate, or subcuneate, margin regularly serrulate, with 25–35 setose-tipped teeth per side, planar to slightly revolute, apex shortly acuminate. Inflorescences axillary and terminal, racemes, sometimes borne below leaves, ca. 1 cm, 3–8-flowered; rachis slender, glabrous; bracts deltoid-ovate, keeled, $1\text{--}2.1 \times 0.8\text{--}1.2$ mm, persistent, glabrous, margin ciliolate and stipitate-glandular, apex acuminate. Pedicel 1.5–5 mm, glabrous; bracteoles basal, otherwise similar to bracts but smaller. Calyx 3–3.8 mm; lobes 5, ovate-deltoid, $2\text{--}2.7 \times 1\text{--}1.4$ mm, glabrous, margin entire, apex acuminate. Corolla white, campanulate, $5\text{--}6 \times 4.5\text{--}5.5$ mm, glabrous; lobes 5, broadly deltoid, 2–3 mm. Filaments 1–1.5 mm, gradually dilated submedially from apex, sparsely villous; anthers 0.8–1 mm, 4-awned; awns 0.2–0.3 mm. Ovary glabrous; style 2.5–3 mm, glabrous. Calyx at fruiting dark purple. Capsule glabrous.

SELECTED ILLUSTRATION.— Airy Shaw, Kew Bull. 1948:160 t. 2(1–4). 1948.

PHOTOGRAPHIC IMAGE.— Figure 27.



FIGURE 27. *Gaultheria notabilis*. Photo by L. Lu.

PHENOLOGY.— Fl. June.

DISTRIBUTION AND HABITAT.— Dry thickets, dry stony slopes, amongst scrub; ca. 2400 m. In GLGS: CHINA. Yunnan: Tengchong Xian; Figure 28. Endemic to GLGS.

CHINESE NAME.— 短穗白珠 *duan sui bai zhu*

15. *Gaultheria nummularioides* D. Don, Prodr. Fl. Nepal, 150. 1825. *Brossaea nummularioides* (D. Don) O. Kuntze, Revis. Gen. Pl. 2:388. 1891. TYPE.— NEPAL. *N. Wallich s.n.* (holotype: BM! ["10?8" on label, third digit illegible]; probable isotype: P! [No. 1524A]).

Gaultheria nummularioides D. Don var. *elliptica* Rehder & E.H. Wilson in Sargent, Pl. Wilson. 1:555. 1913. TYPE.— CHINA. Sichuan: Hung-ya Hsien, near Wa-wu-shan, 1000 m, 8 September 1908, *E.H. Wilson 2708* (holotype: A [image!]; isotypes: GH [image!], K!).

Gaultheria nummularioides D. Don var. *microphylla* C.Y. Wu & T.Z. Xu, Fl. Xizang, 3:697. 1986. TYPE.— CHINA. Xizang: Mainling, *Qinghai-Xizang Exp. 75-1375* (holotype: KUN!).

Gaultheria repens Blume, Bijdr. Fl. Ned. Ind., 857. 1826. *Pernettya repens* (Blume) Zoll. & Moritz in Zoll., Verz. Syst., 3. 1846. TYPE.— INDONESIA. Java: Gede, *C.L. Blume s.n.* (lectotype, here designated: L Herb. Lugd. Bat. No. 903.13-240 (Barcode No. 0007127) [on-line image!]; isolectotypes: K!, L [4] [on-line images!], NY [on-line image!]).

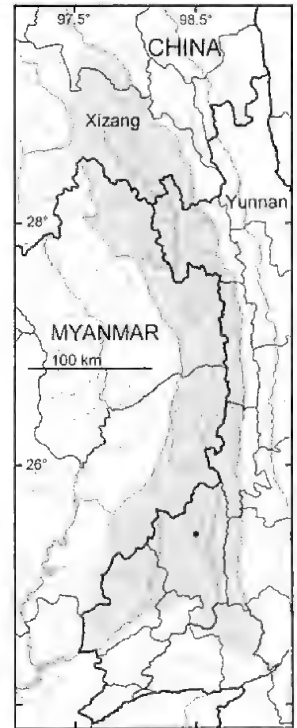


FIGURE 28. Distribution map of *Gaultheria notabilis* in the GLGS region.

No indication of type was indicated in the protologue of *Gaultheria repens*. Sleumer (1957) designated L as lectotype, but there are five sheets of the type material at L and Sleumer annotated all of these as "Type." We designated the L sheet Herb. Ludg. Bat. No. 903.13-240 (Barcode No. 0007127) as the lectotype because it has more material on the sheet than the other four sheets of the type material at L.

Shrublets, prostrate to pendent, occasionally epiphytic. Branchlets elongate and long-trailing, terete to irregularly ridged, wiry, white-puberulent and densely ferrugineous-villous-setose, setae flattened in cross-section. Petiole 0.5–3 mm, ferrugineous-villous-setose and often also white-puberulent; leaf blade ovate, subrhombic, or orbicular, 0.6–2.1 × 0.5–1.9 cm, usually gradually smaller along stems toward both ends of each year's growth, 0.9–1.4 × as long as wide, chartaceous to coriaceous, abaxially green to light brown, occasionally flushed with maroon, usually evenly ferrugineous-setose but occasionally sparsely so or some leaves glabrous, adaxially white-puberulent proximally along midvein, midvein abaxially raised and adaxially planar to impressed or obscure, secondary veins 1 or 2 on each side of midvein, abaxially raised to obscure, adaxially planar to impressed or obscure, tertiary veins abaxially raised to obscure and adaxially usually obscure, base truncate, subrounded, or cordate, margin serrulate, with 7–20 setose-tipped teeth per side, revolute, apex acute to rounded. Inflorescences axillary and occasionally terminal, 0.8–1.2 cm, 1-flowered; pedicel slender, 2–5 mm, glabrous or setulose; bracteoles several, not reaching the apex of pedicel, broadly ovate, not keeled, 2–5 × 1.5–4 mm, persistent, glabrous, margin ciliolate, apex obtuse to rounded. Calyx 3–4.5 mm; lobes 5, ovate, deltoid-ovate, or oblong-ovate, 2–4 × 1.6–2.2 mm, glabrous, margin ciliolate, apex acuminate. Corolla white to deep red, campanulate, 5–6 × 3–8 mm, outside glabrous, inside dull yellow- to ferrugineous-pubescent to -pilose; lobes 5, deltoid, 1.2–2 mm. Stamens 10; filaments 1.5–2 mm, gradually dilated subbasally from apex, densely yellow- to ferrugineous-pilose; anthers 1.3–1.5 mm, awns 0.4–0.5 mm. Ovary glabrous; style 2–3 mm, glabrous. Calyx at fruiting dark purple to black, fleshy; lobes erect, not pale-edged. Capsule 4–6 mm in diam., glabrous.

SELECTED ILLUSTRATIONS.— R.C. Fang, *Fl. Reipubl. Popularis Sin.* 57(3):64 t. 19(1–5). 1991; G.H. Zhu & L.B. Zhang, eds. *Fl. China* III. 14: t. 666(1–5). 2006.

PHOTOGRAPHIC IMAGES.— Figures 29–30.

PHENOLOGY.— Fl. Jul–Oct, fr. Aug–Jul.

DISTRIBUTION AND HABITAT.— Subtropical evergreen broadleaf forests, deciduous broadleaf forests, coniferous forests, meadows, thickets, often on rocks; 1300–4600 m. In GLGS: CHINA. Xizang: Zayü Xian (Tsarong Xiang). Yunnan: Fugong Xian (Lishadi Xiang, Lumadeng Xiang), Gongshan Xian (Bingzhongluo Xiang, Cikai Zheng, Dulongjiang Xiang), Tengchong Xian (Jietou Xiang, Mazhan Xiang, Qushi Xiang), MYANMAR. Kachin: Putao District (Nogmung Township); Figure 31. Outside of GLGS: Sichuan, Xizang, Yunnan [Bangladesh, Bhutan, India, Indonesia, Malaysia, Myanmar, Nepal].

CHINESE NAME.— 铜钱叶白珠 *tong qian ye bai zhu*

GAOLIGONG SHAN SPECIMENS EXAMINED: CHINA. XIZANG: ZAYÜ XIAN. Putsang River, Rong To Valley, 1933, *KW 10960* (BM); Tsari Chu, Podzo Stumdo, SE Xizang, 11500 ft., 15 Oct 1938, *F. Ludlow & G. Sherriff 6356* (A, E); Zhu Wa Geng, 2700 m, 2 Jul 1973, *QX 73-542* (KUN); Ri Dong Qu, 3000 m, 7 Sep 1982, *QX 10056* (KUN). **Tsarong Xiang.** Salwin-Kiu Chiang divide, 14000–14500 ft., 1920, *F 19867* (E, K, P [2]); Salwin-Kiu Chiang divide, 14500 ft., Oct 1921, *F 20871* (E, K, P). **YUNNAN: FUGONG XIAN.** Da You Team to Ma Shi Ding, 1 Aug 1979, *Q. Lin 791942* (KUN). **Lishadi Xiang.** Between Shibali Logging Station and Yaping Pass, ca. 7.2 km W of Shibali, rd from the Nuijiang to Yaping Pass, E side of Gaoligong Shan, 2786 m, 2 May 2004, *GLGS 20182* (CAS); Yaduo Cun, above Shibali, S side of N fork of



FIGURE 29. Fruiting individuals of *Gaultheria nummularioides*. Photo by P. Fritsch.



FIGURE 30. Flowering individual of *Gaultheria nummularioides*. Photo by L. Zhou.

the Yamu He, rd to Myanmar border at Yaping Yakou, E side of Gaoligong Shan, 2830 m, 6 Aug 2005, *GLGS* 26533 (CAS); Yaduo Cun, along rd from Shibali to Myanmar border at Yaping Yakou, E side of Gaoligong Shan, 2830 m, 8 Aug 2005, *GLGS* 26706 (CAS). **Lumadeng Xiang**. Yaping Cun, vicinity of Shibali, S side of N fork of the Yamu He, E side of Gaoligong Shan, 2510 m, 16 Aug 2005, *GLGS* 28473 (CAS). **GONGSHAN XIAN**. Salwin-Kiu Chiang divide, 15000 ft., 1 Oct 1921, *F* 20868 (E, K); Salween Valley, Bahanlo, 23 Nov 1959, *Feng* 24691 (KUN). **Bingzhongluo Xiang**. Alulaka, in regionis temperatae ad fluvium Lu-djiang (Salween), 2900–3200 m, 31 Jul 1916, *H.F. v. Handel-Mazzetti* 9589 (A, P); in regionis temperatae ad fluvium Lu-djiang (Salween) prope Tschamutong, Tjiongatong, 3000 m, 8 Aug 1916, *H.F. v. Handel-Mazzetti* 9763 (E); Di Ma Luo, 2500 m, 25 Nov 1979, *R.Q. Li* 1 (KUN); same data, *R.Q. Li* 3 (KUN); Si Ji Tong, Chang Pu Tong, 2800 m, Oct 1935, *W.C. Wang* 67144 (A); same locality, 2500 m, Oct 1935, *W.C. Wang* 67181 (A, KUN); same locality, 3000 m, Oct 1935, *W.C. Wang* 67511 (A). **Cikai Zheng**. E side of Gaoligong Shan, W of Gongshan, vicinity of Qiqi above the Pula He, 2300–2570 m, 12 Jul 2000, *GLGS* 12494 (CAS, KUN); E side of Gaoligong Shan, W of Gongshan, along the Pula He, trail from Qiqi to Dongshaofang and the Dulongjiang Valley, 2770–3050 m, 15 Jul 2000, *GLGS* 12550 (CAS, E, KUN); Danzhu, No. 1 Bridge, E side of Gaoligong Shan, 2080 m, 15 May 2001, *GLGS* 13771 (CAS, KUN); Labadi, along a branch of the Pula He, rd from Gongshan to Kongdang, E side of Gaoligong Shan, 3000 m, 29 Sep 2002, *GLGS* 16708 (CAS); along rd from Gongshan to Kongdang, E side of Gaoligong Shan, 3340 m, 1 Oct 2002, *GLGS* 16818 (CAS, KUN); N of rd from Gongshan to Kongdang, E side of Gaoligong Shan, u-shaped valley draining into the upper reaches of the Pula He, 3429 m, 3 Oct 2002, *GLGS* 16953 (CAS); along rd from Gongshan to Kongdang, E side of Gaoligong Shan, 2510 m, 10 Oct 2002, *GLGS* 17128 (CAS, KUN); E side of Gaoligong Shan, rd from Danzhu to the Myanmar border, 2700 m, 10 Nov 2004, *GLGS* 22344 (CAS); E side of Gaoligong Shan, rd from Gongshan to Kongdang, ca. 29 km from Gongshan, 2940 m, 12 Nov 2004, *GLGS* 22520 (CAS); E side of Gaoligong Shan, rd from Gongshan to Kongdang, 2720 m, 12 Nov 2004, *GLGS* 23073 (CAS); same locality, 2530 m, 12 Nov 2004, *GLGS* 23099 (CAS); vicinity of Dimupo, ca. 7 direct km WNW of Gongshan, rd from Gongshan to Kongdang, E side of Gaoligong Shan, 2530 m, 17 Aug 2006, *GLGS* 33689 (CAS); vicinity of Cikeluo Qiao near Km 41, rd from Gongshan to Kongdang and ca. 16.8 direct km WNW of Gongshan, E side of Gaoligong Shan, 3030 m, 21 Aug 2006, *GLGS* 33810 (CAS); same data, *GLGS* 33876 (CAS); Danzhu Cun, vicinity of Elong Shankou at Myanmar border, ca. 15.7 direct km WSW of Danzhu, E side of Gaoligong Shan, 3250 m, 24 Aug 2006, *GLGS* 34057 (CAS); Heiwadi Cun, vicinity of Dimupo, rd from Gongshan to Kongdang, ca. 6.4 direct km WNW of Gongshan, E side of Gaoligong Shan, 2380 m, 27 Aug 2006, *GLGS* 34188 (CAS); vicinity of Dimupo, near Km 28, rd from Gongshan to Kongdang, ca. 8.5 direct km W of Gongshan, E side of Gaoligong Shan, 2700 m, 30 Aug 2006, *GLGS* 34352 (CAS); Qiqi trail to No. 12 Bridge, 1700–2600 m, 2 Jun 2006, *Lu* 28 (CAS [2]); E slope of Gaoligong Shan, 2900–3200 m, 26 Jul 1982, *QX* 8751 (KUN). **Dulongjiang Xiang**. Vicinity of Nengpula, directly opposite Bapo, W side of the Dulongjiang, 1400 m, 11 Dec 1990, *GLGS* 977 (CAS, KUN); vicinity of Kongdang, E side of the Dulongjiang, 2600 m, 2 Jan 1991, *GLGS* 1579 (CAS, KUN); Mo Qie Wang, 1704 m, 9 Jan 1991, *GLGS* 1704 (KUN); Neng Pu La, 1300 m, 6 Feb 1991, *GLGS* 3948 (KUN); Wang Nu La Ka, 2300 m, 18 Apr 1991, *GLGS* 6049 (KUN); the third team, 2800 m, 20 May 1991, *GLGS* 6954 (KUN); N of the third team, 2900 m, 22 May 1991, *GLGS* 7040 (KUN); Dongshaofang, 2890 m, 16 Oct 1991, *GLGS* 7677 (E); Qiqi to Dongshaofang, 2870 m, 14 Oct 1991, *GLGS* 7735 (KUN); Dongshaofang, 2890 m, 14 Oct 1991, *GLGS* 7794 (E, KUN); Qiqi to Dongshaofang, 3290 m, 21 Sep 1997, *GLGS* 9517 (E, KUN); vicinity of Xixiaofang, trail from Bapo to Gongshan via Qiqi, W side of Gaoligong Shan, 2970 m, 30 Oct 2004, *GLGS* 22006 (CAS); above Sandui campsite between Shigong Qiao and Xixiaofang, trail from Bapo to Gongshan via Qiqi, W side of Gaoligong Shan, 2760 m, 1 Nov 2004,

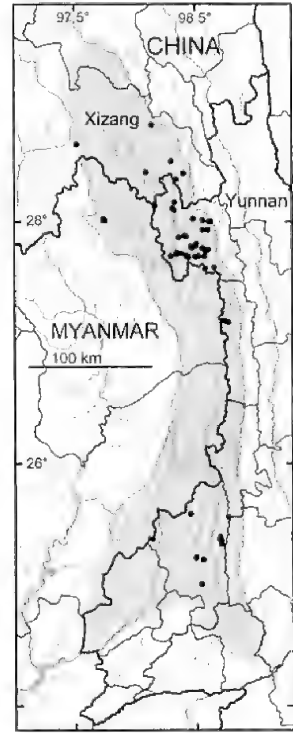


FIGURE 31. Distribution map of *Gaultheria nummularioides* in the GLGS region.

GLGS 22083 (CAS [2]); along rd between Kongdang the Heipu Pass tunnel on new rd from Gongshan to Dulongjiang Valley, ca. 8.4 direct km E of Kongdang, W side of Gaoligong Shan, 2460 m, 15 Aug 2006, *GLGS 32379* (CAS); above Maku, 2760 m, 20 Aug 2006, *GLGS 32754* (CAS); prope fines Tibeto-Burmanicas in convalle fluvii Djiou-djiang (Irrawadi or sup.), in pluviisilva mixta temperata supra vicum Schutsche, 2800–2900 m, 9 Jul 1916, *H.F. v. Handel-Mazzetti 9449* (A, E); Qiqi, Songdu, 2200, 21 Jul 1982, *QX 8254* (KUN); Long Yuan, 2300 m, 30 Aug 1982, *QX 9776* (KUN); Mt. Chingtinglaka, 2400 m, 28 Jul 1938, *Yü 19501* (A, E); Salween-Kiukiang divide, E of Wangtzang, 2600 m, 13 Sep 1938, *Yü 20232* (A, E); Salween-Kiukiang divide, Muchielung, 1800 m, 8 Oct 1938, *Yü 20574* (A, E, KUN); Salween-Kiukiang divide, Panbahlung, 2500–3000 m, 22 Oct 1938, *Yü 20822* (KUN); Salween-Kiukiang divide, Panbahlung, 3000 m, 22 Oct 1938, *Yü 20830* (A, E, KUN); Salween-Kiukiang divide, Swangochiang, 2800 m, 13 Jul 1938, *Yü 22085* (A, E, KUN); same locality, 2800 m, 5 Nov 1937, *Yü 22965* (KUN); Salween Valley, Bahanlo, 3000 m, 27 Sep 1938, *Yü 23115* (A, E, KUN). **TENGCHONG XIAN.** Hills E of Tengyueh, 6500 ft., Jul 1912, *F 8780* (E, K); same location, 6500–7000 ft., Dec 1912, *F 9364* (E); Shweli-Salwin divide, 7000–8000 ft., Jul 1918, *F 17579* (E, K); same locality, 7000–8000 ft., Sep 1924, *F 25172* (E, K, P); Salween-Irrawaddy divide, E flank, 11000–12000 ft., 21 Oct 1922, *KW 5429* (E); between Tengyueh and Burmese border, en route to Sadon, Nov 1922, *Rock 7384* (A, E). **Jietou Xiang.** Shaba Cun, community forest of Lidazhai, W side of Gaoligong Shan, 1800 m, 23 Dec 2000, *GLGS 13596* (CAS); Zhongping Cun, vicinity of Lijia Zhai, W side of Gaoligong Shan, 2420 m, 24 May 2006, *GLGS 29505* (CAS); same locality, 1820 m, 24 May 2006, *GLGS 29522* (CAS). **Mazhan Xiang.** Xiaokong Shan Volcano N of Tengchong, 1930 m, 25 Oct 1998, *GLGS 10941* (CAS, KUN [2]); Dakong Shan Volcano, 2040 m, 2 Jun 2006, *GLGS 29885* (CAS). **Qushi Xiang.** Bai Jia He, 1740 m, 4 Sep 1960, *Yin 60-1241* (KUN). **MYANMAR. KACHIN: PUTAO DISTRICT. Nongmung Township.** Nam Tamai Valley, Mungku Hkyet, 8000–9000 ft., 19 Aug 1937, *KW 12971* (BM); same locality, 9000–10000 ft., 8 Sep 1937, *KW 13172a* (BM); same data, *KW 13172* (BM); same locality, 8000–9000 ft., *KW 13478* (BM).

16. *Gaultheria praticola* C.Y. Wu & T.Z. Xu, *Acta Bot. Yunnan.* 3:425. 1981. TYPE.—CHINA. Yunnan: Deqin, 3600–4000 m, *K.M. Feng 6190* (holotype: KUN!).

The specimen *K.M. Feng 6190* (KUN) is stamped “ISOTYPUS;” one duplicate of *K.M. Feng 24033* (KUN) is stamped “TYPUS” and another “ISOTYPUS.” The protologue clearly indicates that *K.M. Feng 6190* at KUN is the holotype and that *K.M. Feng 24033* is not part of the type material.

Shrublets 15–30 cm tall, prostrate to decumbent. Stems unbranched or branchlets elongate, terete, densely tawny- to dull orange-pilose-villous and white-puberulent. Petiole 2–4 mm, pilose-villous; leaf blade broadly elliptic to ovate-elliptic, with sides often nearly parallel, 3.6–8.4 × 2.2–5 cm, 1.1–2.2 × as long as wide, subcoriaceous, abaxially green to brown- and tawny- to dull orange-pilose or rarely -setulose, adaxially glabrous, midvein abaxially prominent and adaxially narrowly sulcate, secondary veins (2)3–5 on each side of midvein, arising along midvein with proximal veins becoming faint or anastomosing before reaching apex, abaxially prominent, adaxially planar to impressed, tertiary veins abaxially raised and adaxially planar to impressed, base rounded, subrounded, subtruncate, or subcordate, margin regularly serrulate, with 25–65 setose-tipped teeth per side, planar to slightly revolute, apex acute to rounded and often cuspidate. Inflorescences axillary and terminal, open racemes, 1.3–3 cm, 1–6-flowered; rachis slender, white- to yellow-puberulent to -villulose; bracts broadly ovate, not keeled, 2–4 × 1.7–3.6 mm, persistent, glabrous or rarely adaxially white-hirtellous toward apex, margin ciliate, apex rounded. Pedicel 2–6 mm, glabrous or puberulent; bracteoles medial, deltoid, 1–1.5 × 1–1.4 mm, glabrous, otherwise similar to bracts. Calyx 2.3–2.5 mm; lobes 5, deltoid-ovate, 1.3–2.2 × 1.3–2 mm, glabrous, margin ciliate, apex acute. Corolla white to purplish green, campanulate to urceolate-globose, 4–5.5 × 4.5–6 mm, glabrous; lobes 5, deltoid, oblong, or ± hemispherical, 0.8–2.5 mm. Stamens 10; filaments 1.5–1.8 mm, gradually dilated medially from apex, glabrous; anthers 1.2–1.3 mm, awns ca. 0.8 mm. Ovary

thinly strigillose; style 2–4.5 mm, glabrous. Calyx at fruiting black, occasionally glaucous, fleshy; lobes incurved, not pale-edged. Capsule 5–6 mm in diam., thinly strigillose.

SELECTED ILLUSTRATION.— T.Z. Xu, *Acta Bot. Yunnan.* 3:425 t. 3(1–7). 1981.

PHENOLOGY.— Fl. Jun–Jul, fr. Sep–Oct.

DISTRIBUTION AND HABITAT.— Coniferous forests, grassy slopes, on rocks in thickets, meadows; 3000–3500 m. In GLGS: CHINA. Yunnan: Fugong Xian, Gongshan Xian (Cikai Zheng), Tengchong Xian; Figure 32. Outside of GLGS: SE Xizang, NW Yunnan.

CHINESE NAME.— 草地白珠 *cao di bai zhu*

GAOLIGONG SHAN SPECIMENS EXAMINED: CHINA. YUNNAN: FUGONG XIAN. Jiang Sha Logging Station, 3500 m, 19 Jun 1978, *BE 611* (KUN). **GONGSHAN XIAN.** Hill behind Kongmu Community Team, 3500–3800 m, 17 Jul 1979, *NE 79-1102* (KUN). **Cikai Zheng.** N of rd from Gongshan to Kongdang, E side of Gaoligong Shan, u-shaped valley draining into the upper reaches of the Pula He, 3350 m, 3 Oct 2002, *GLGS 16928* (CAS, KUN); Heipu Pass along rd from Gongshan to Dulongjiang Valley, E side of Gaoligong Shan, 3490 m, 12 Aug 2006, *GLGS 32056* (CAS); Dong Shao Fang Pass, 3400–3500 m, 4 Jun 2006, *Lu 56* (CAS). **TENGCHONG XIAN.** Shweli-Salween divide, 10000 ft., Jul 1919, *F 18141* (A, E, K).

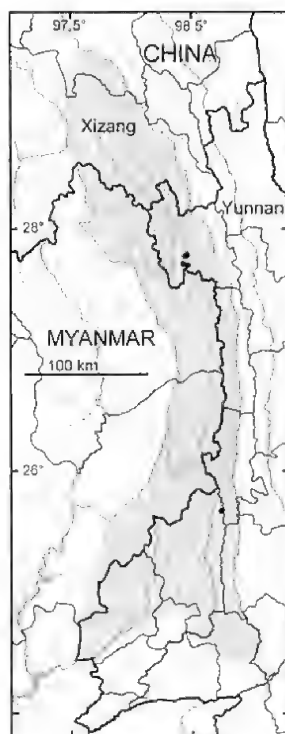


FIGURE 32. Distribution map of *Gautheria praticola* in the GLGS region.

17. *Gaultheria pseudonotabilis* H. Li ex R.C. Fang, Novon 9:169. 1999. TYPE.— CHINA. Yunnan: Gongshan Xian, Dulongjiang Xiang, Qin Liang Dang [Gaoligong Shan], 1350 m, 9 March 1991, *Dulongjiang Investigation Team [GLGS] 4446* (holotype: KUN!; isotype: KUN!).

Shrubs 1–2 m tall, arching. Branchlets elongate, terete, densely dull orange- to brown-setose-hirsute and usually white-puberulent. Petiole 3–6 mm, setose-hirsute; leaf blade narrowly cordate, ovate, or lanceolate, $7.3\text{--}13.6 \times 3.7\text{--}6.5$ cm, $1.8\text{--}3.0 \times$ as long as wide, coriaceous, abaxially greenish brown to brown and glabrous or white-puberulent along major veins, adaxially glabrous, midvein abaxially prominent and adaxially sulcate, secondary veins 1 on each side of midvein and extending to apex, usually an additional more irregular pair toward margins, abaxially prominent, adaxially sulcate, inner tertiary veins 6–12 on each side of midvein, abaxially prominent, abaxially impressed, base cordate, margin irregularly denticulate, with many setose-tipped teeth, planar to slightly revolute, apex long-acuminate. Inflorescences axillary and terminal, somewhat open umbelliform racemes, 2–3.8 cm, 3–11-flowered; rachis stout, glabrous; bracts suborbicular, keeled, $2.5\text{--}4.5 \times 2\text{--}3.5$ mm, persistent, glabrous, margin ciliolate and setulose, apex aristate. Pedicel 0.8–1.4 cm; bracteoles basal, ciliolate, otherwise similar to bracts. Calyx 4–5 mm; lobes 5, deltoid-ovate, ca. $3 \times 2.5\text{--}3$ mm, glabrous, margin entire, apex acuminate. Corolla green, pink, red, or white, broadly campanulate, $6\text{--}8 \times 7\text{--}12$ mm, glabrous; lobes 5, deltoid, 1.5–4 mm. Stamens 10; filaments 2.5–3 mm, rather abruptly dilated medially from apex, glabrous; anthers 2.5–3 mm, awns 0.2–0.3 mm. Ovary glabrous; style 4–6 mm, glabrous. Calyx at fruiting dark purple to black, rather fleshy; lobes incurved, not pale-edged. Capsule 7–11 mm in diam., glabrous.

SELECTED ILLUSTRATION.— R.C. Fang, *Novon* 9:170 t. 5. 1999.

PHENOLOGY.— Fl. Feb–Apr, fr. Jun–Sep.

DISTRIBUTION AND HABITAT.— Subtropical evergreen broadleaf forests, deciduous broadleaf forests, *Taiwania* forests, thickets, on rocks; 1300–3000 m. In GLGS: CHINA. Yunnan: Gongshan Xian (Cikai Zheng, Dulongjiang Xiang); Figure 33. Endemic to GLGS.

CHINESE NAME.— 假短穗白珠 *jia duan sui bai zhu*

ADDITIONAL GAOLIGONG SHAN SPECIMENS EXAMINED: CHINA.

YUNNAN: GONGSHAN XIAN. 1300 m, 26 Nov 1959, *Feng 24731* (KUN); from Gongshan to Qiqi, 1600–1800 m, 2 Jun 2006, *Lu 108* (CAS [2]). **Cikai Zheng.** E side of Gaoligong Shan, W of Gongshan and E of Qiqi along the Pula He, vicinity of Qiqi Bridge, 1850 m, 10 Jul 2000, *GLGS 12221* (CAS, KUN); E side of Gaoligong Shan, W of Gongshan, along the Pula He, trail from Gazu to Qiqi and Dulongjiang Valley, 1800 m, 4 May 2002, *GLGS 14937* (CAS, KUN); trail from Gongshan to Qiqi, E side of Gaoligong Shan, 1550 m, 25 Sep 2002, *GLGS 16565* (CAS, KUN); vicinity of Mangzhou Wadi, S side of the Danzhu He, ca. 13.6 direct km WSW of Danzhu Cun and ca. 14.8 direct km SW of Gongshan, E side of Gaoligong Shan, 3000 m, 12 Aug 2006, *GLGS 33113* (CAS); Danzhu Cun, vicinity of Luomoduo, S slope of the Danzhu He ca. 6.2 direct km SW of Danzhu, E side of Gaoligong Shan, 1950 m, 16 Aug 2006, *GLGS 33398* (CAS). **Dulongjiang Xiang.** Vicinity of Nengpula, directly opposite Bapo, W side of the Dulongjiang, 1400 m, 8 Dec 1990, *GLGS 915* (CAS); along the Dandang-wang He, NW of Bapo, W side of the Dulong Jiang, 1400 m, 16 Jan 1991, *GLGS 3149* (CAS); along the Gamolai He, trail from Bapo to Gongshan, E side of the Dulongjiang, 1350 m, 26 Jan 1991, *GLGS 3406* (CAS); vicinity of Kongdang, E side of the Dulong Jiang, 1450 m, 2 Mar 1991, *GLGS 4115* (CAS, KUN); Mo La Dang, 1400 m, 3 Mar 1991, *GLGS 4152* (KUN); Maku, 1850 m, 7 Apr 1991, *GLGS 4231* (KUN); vicinity of Mabidang, ca. 5 km N of Bapo, E side of the Dulongjiang, 1400 m, 8 Mar 1991, *GLGS 4634* (CAS); Dong Shan Ping, 1400 m, 9 Mar 1991, *GLGS 4669* (KUN); Bapo, 1350 m, 7 Apr 1991, *GLGS 5395* (KUN); Bapo, 1350 m, 15 May 1991, *GLGS 6738* (KUN); Mei Li Wang, 1800 m, 21 May 1991, *GLGS 7013* (KUN).

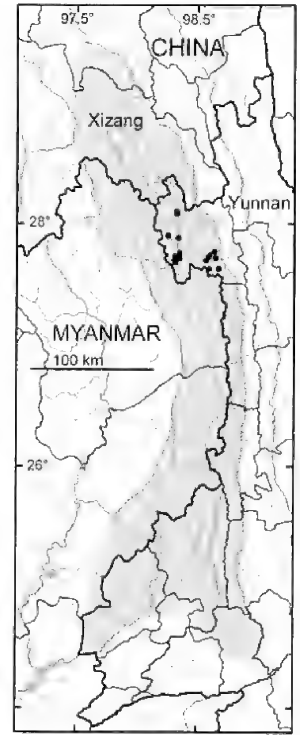


FIGURE 33. Distribution map of *Gaultheria pseudonotabilis* in the GLGS region.

18. *Gaultheria pyrolifolia* J.D. Hooker ex C.B. Clarke, Fl. Brit. India 3:457. 1882 ["*pyrolae-folia*"]. TYPE.— INDIA. Sikkim: Lachen, 13000 ft., 20 Jun 1849, *J.D. Hooker s.n.* (lectotype, designated by Fritsch and Trock (2007): K image catalogue number K00406!; probable isolectotypes: E!, GH!, NY [on-line image!], P!).

Shrublets 3–50 cm tall, decumbent, gynodioecious. Branchlets not notably elongate, terete, densely white-puberulent and occasionally with scattered uncinat-ascending stipitate glands or rarely setae. Petiole 1–4 mm, glabrous; leaf blade elliptic, suborbicular, obovate, or oblanceolate, 1.4–3.7 × 0.8–2.3 cm, 1.2–2.5 × as long as wide, coriaceous, abaxially olive-green to brown and orange- to dark red-appressed-stipitate-glandular, adaxially glabrous, veins abaxially raised or prominent and adaxially deeply impressed, secondary veins 2–4 on each side of midvein, arising along midvein with proximal veins becoming faint or anastomosing before reaching apex, base cuneate to rounded, margin serrulate, with 8–19 setulose-glandular teeth per side, revolute, apex acute to rounded. Inflorescences terminal and axillary, open racemes, usually subterminal or rarely borne below leaves, 1–2.2 cm, 1–5-flowered; rachis slender, sparsely to densely white-puberulent to -pubescent, rarely ferrugineous-setose; bracts broadly ovate to suborbicular, not keeled, 2.3–5 × 2–3.5 mm, persistent, glabrous, margin entire or ciliolate, apex obtuse to rounded. Pedicel 3–8 mm, glabrous, white-puberulent, or rarely ferrugineous-setulose; bracteoles ± medial, ovate, 1.6–3.5 × 0.7–1.5 mm, apex acute, otherwise similar to bracts. Calyx 1.8–3.5 mm; lobes 5, deltoid to deltoid-

ovate, $1.5\text{--}2.5 \times 1.3\text{--}2$ mm, glabrous, margin entire or ciliolate, apex acute. Corolla white, pink, or white flushed with pink, urceolate, $4\text{--}5 \times 2.5\text{--}4$ mm, outside glabrous or rarely white-puberulent, inside glabrous or rarely tawny-puberulent; lobes 5, oblong, ca. 0.5 mm. Staminodes (in female flowers) ca. 1.2 mm, with narrowly sagittate anther-like apex. Stamens 10; filaments 1.5–2 mm, gradually dilated medially from apex, glabrous; anthers 1–1.2 mm, awns 0.6–1 mm. Ovary glabrous or sparsely white-puberulent; style 2–2.5 mm, glabrous. Calyx at fruiting dark purple, glaucous, fleshy; lobes \pm erect, pale-edged. Capsule 4.5–7 mm in diam., glabrous or sparsely puberulent.

Fritsch and Trock (2007), in recently lectotypifying both *Gaultheria pyrolifolia* and the Japanese and Alaskan species *G. pyroloides*, claimed that *G. miqueliana* Takeda, another name for the Japanese species, is nomenclaturally superfluous and thus illegitimate because the earlier name *G. pyroloides* was cited in its synonymy. Dr. K. Gandhi of Harvard University considers *G. miqueliana* to be legitimate because Takeda (1918) excluded part of the type material (Himalayan collections of J.D. Hooker & T. Thomson) from the type of *G. miqueliana*, and thus by implication retained the Japanese portion of the type material for this name (pers. comm.). There appears to be some debate as to whether this method of inclusion of type is contrary to the relevant section (Article 52) of the International Code of Botanical Nomenclature (McNeill et al. 2006). We make no attempt here to resolve this issue, but merely point out that if the above assertion is the correct interpretation of the code, then Fritsch and Trock's (2007) reason number three (3) under the lectotypification of *G. pyroloides* (p. 101) must be discounted as a basis for the choice of lectotype for this name. As affirmed by Gandhi, the other two reasons given as justification (there were two names clearly available for both the Himalayan and Japanese species when *G. miqueliana* was published, and the original description of *G. pyroloides* is essentially based on the Japanese part of the type material) are nonetheless sufficient for the choice of *G. pyroloides* over *G. miqueliana* for the Japanese species, even if *G. miqueliana* is legitimate.

Several GLGS specimens appear to be morphologically intermediate between *Gaultheria hookeri* and *G. pyrolifolia* (e.g., GLGS 16935 and 33822, F. Ludlow et al. 1397, J. Rock 22335 and 22435, T.T. Yü 20672). Such intermediates have suborbicular leaves, as in *G. pyrolifolia*, but relatively long, erect-ascending trichomes (rather than appressed) that are not tipped by a conspicuous gland, as in *G. hookeri*. They also can be intermediate in stature and leaf size. *Gaultheria pyrolifolia* shares features of several other Asian species of *Gaultheria* (decumbent habit, stipitate glands, relatively small leaves with a short petiole, and few-flowered racemes; *G. borneensis* Stapf, *G. cuneata*, and *G. pyroloides*), but these species all have white fruit, in contrast to the blue fruit of *G. pyrolifolia*. This blue color is the same as that in *G. hookeri*. Moreover, preliminary phylogenetic data based on DNA sequences (C. Bush et al., unpubl. data) place *G. pyrolifolia* strongly with *G. hookeri* rather than these other species. Thus, morphological features and results from phylogenetic analysis both suggest reticulate evolution between *G. hookeri* and *G. pyrolifolia*. The specific nature of the reticulation (introgression, hybrid speciation) will require extensive population sampling, field observations, and molecular marker data.

SELECTED ILLUSTRATION.— Anonymous, Ic. Cormophyt. Sin. 3:185, t. 4324. 1974.

PHENOLOGY.— Fl. Jun–Jul, fr. Aug–Sep.

DISTRIBUTION AND HABITAT.— Alpine rocky windswept areas, ledges of cliffs; 2900–4400 m. In GLGS: CHINA. Xizang: Zayü Xian (Tsarong Xiang). Yunnan: Gongshan Xian (Bingzhongluo Xiang, Dulongjiang Xiang), MYANMAR. Kachin: Putao District (Nogmung Township); Figure 34. Outside of GLGS: SE Xizang, [Bhutan, India, Myanmar, Nepal].

CHINESE NAME.— 鹿蹄草叶白珠 lu ti cao ye bai zhu

GAOLIGONG SHAN SPECIMENS EXAMINED: CHINA. XIZANG: ZAYÜ XIAN. Bimbi La, Tsari, SE Tibet, 9500–10500 ft., 6 Jun 1936, *F. Ludlow & G. Sherriff* 1782 (E); Lang La, SE Xizang, 13000 ft., 17 Oct 1947, *F. Ludlow et al.* 13323 (E); Ba La Pasum Chu, SE Tibet, 14500 ft., 22 Jun 1947, *F. Ludlow et al.* 13972 (E [2]); Da Yang La, SE Xizang, 13500 ft., 4 Apr 1947, *F. Ludlow & G. Sherriff* 15143 (A [2], E [2]). **Tsarong Xiang.** Salwin-Kiu Chiang divide, 13000–14000 ft., Jul 1921, *F* 19865 (E, K, P [2]); mts. of Tjonatong, upper Salwin River, 14500 ft., Jun 1932, *Rock* 22340 (A, E, K); mts. of Wuli-la, E of the Salwin River and N of Alulaka, 14500 ft., Jun 1932, *Rock* 22436 p.p. (A, E, K). **YUNNAN: GONGSHAN XIAN.** Bingzhongluo Xiang. Chang Pu Tong, 3700–3700 m, 20 Sep 1940, *NE* 7876 (KUN). **Dulongjiang Xiang.** Upper Kiukiang Valley (Clulung), S of Lung-tasahmuru, 4000 m, 10 Aug 1938, *Yü* 19879 (A, E, KUN). **MYANMAR. KACHIN: PUTAO DISTRICT.** Nongmung Township. Adung Valley, 12000–13000 ft., 17 Jun 1931, *KW* 9648 (A).

19. *Gaultheria semi-infera* (C.B. Clarke) Airy Shaw, Bull. Misc. Inform. Kew 1940:306. 1941. Basionym: *Diplycosia semi-infera* C.B. Clarke, Fl. Brit. India 3:459. 1882. TYPE.—BHUTAN. 7000–9000 ft., *W. Griffith* (*Kew Distrib. no.* 3482) (holotype: K!; isotype: L [on-line image!]).

Gaultheria tetramera W.W. Smith, Notes Roy. Bot. Gard. Edinburgh 11:211. 1919. TYPE.—CHINA. Yunnan: [Tengchong Xian], hills east of Teng-yueh [Gaoligong Shan], 25°N, 6000 ft., May 1912, *G. Forrest* 7702 (lectotype, here designated: E!; isolectotypes: A!, K!).

Gaultheria forrestii Diels var. *setigera* C.Y. Wu & T.Z. Xu, Acta Bot. Yunnan. 3:427. 1981. TYPE.—CHINA. Yunnan: Jingdong, *M.K. Li* 2188 (holotype: KUN; isotype: KUN!).

There are six collections listed in the protologue of *Gaultheria tetramera* (*G. Forrest* 7702, 8757, 8786, 9331, 14882, and 15986), none of which is specifically denoted as the type. We have designated the E duplicate of *G. Forrest* 7702 as the lectotype because E is the herbarium at which W.W. Smith worked and this is the only sheet of any of the E syntypes that we have seen (we have seen all except 14882) with the handwritten word “Type.” We have not been able to determine whether this is Smith’s handwriting.

Shrubs 0.2–4 m tall, erect or arching, gynodioecious. Branchlets not notably elongate, terete to slightly angulate, evenly scattered to densely tawny-, gray-, ferruginous-, brown-, or black-appressed to -ascending-setose and white-puberulent. Petiole 2–7 mm, glabrous or puberulent or setose or both; leaf blade elliptic, linear-elliptic, obovate, oblanceolate, or linear-oblanceolate, 2.6–10.8 × 1–4.2 cm, 1.7–7.3 × as long as wide, subcoriaceous, abaxially light green and ferruginous-, red-, brown-, or black-gland-dotted or -setose, adaxially glabrous or white-puberulent proximally along midvein, midvein abaxially prominent and adaxially narrowly sulcate, secondary veins 3–5 on each side of midvein, arising along midvein with proximal veins becoming faint or anastomosing before reaching apex, abaxially prominent to raised, adaxially impressed to occasionally planar, tertiary veins abaxially raised and adaxially impressed to occasionally planar, base narrowly cuneate to subrounded, margin regularly serrulate, with 10–30 teeth per side, planar to revolute, apex acute to obtuse. Inflorescences terminal and axillary, rather dense racemes with flowers ± secund, often borne below leaves, 0.8–4 cm, 1–22-flowered; rachis slender, white-pubescent to -puberulent; bracts deltoid to deltoid-ovate, keeled, 1.2–2.8(–3.7) × 0.8–1.8(–2.4) mm, per-

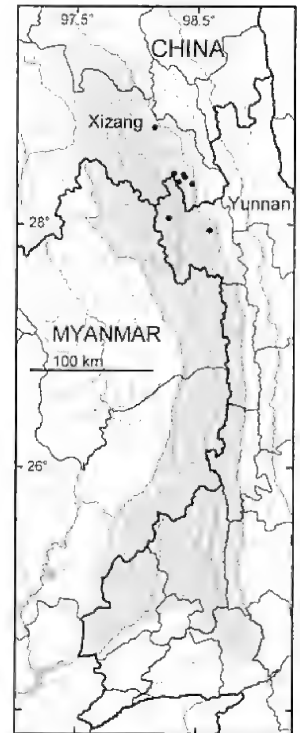


FIGURE 34. Distribution map of *Gaultheria pyrolifolia* in the GLGS region.

sistent, abaxially white-puberulent or occasionally glabrous, adaxially white-strigillose or glabrous, margin ciliolate or stipitate-glandular or both, apex acute to acuminate and often recurved. Pedicel 0.5–4 mm, white-puberulent; bracteoles apical or subapical, deltoid, 1.1–2.1 × 0.7–1.2 mm, otherwise similar to bracts. Calyx 2.2–2.7 mm; lobes (2 or 3)4 or 5, deltoid, 1.8–2.2 × 0.8–1.6 mm, glabrous, margin ciliolate or stipitate-glandular or both, apex acute to acuminate. Corolla white, pink, purplish pink, whitish yellow, or greenish white, urceolate, 2–3.5 × 2–3 mm, outside glabrous, inside sparsely to densely white-puberulent to -villulose or rarely glabrous; lobes 4 or 5, oblong, 0.3–0.6 mm. Staminalodes (in female flowers) 5 or 6, with minute anther-like apex 0.5–0.9 mm. Stamens usually 5 (in flowers with 4 or 5 calyx and corolla lobes) or 8 (in flowers with 4 calyx and corolla lobes), occasionally 2–4 or 6; filaments 0.5–1.3 mm, gradually dilated subbasally from apex, glabrous; anthers 0.6–0.8 mm, awns 0.3–0.7 mm. Ovary ± semi-inferior, white-pilulose; style 1–2.3 mm, white-strigillose or -pilulose at least proximally or occasionally glabrous. Calyx at fruiting blue, bluish white, or purple, fleshy; lobes ± erect, pale-edged. Capsule 3–5 mm in diam., pilulose-sericeous.

Gaultheria tetramera has been considered distinct from other species of *Gaultheria* by several authors (Airy Shaw 1941; Xu 1991a; Fang and Stevens 2005), mainly through its 4-merous flowers (versus 5-merous in other racemose species). In addition, Smith (1919) noted the smaller leaves of *G. tetramera*, in contrast to those of *G. fragrantissima* and *G. veitchiana* (= *G. hookeri*), whereas Fang and Stevens (2005) used width as a key character in addition to the difference in merosity (ca. 2 × as long as wide versus 2.5–4 × as long as wide in *G. semi-infera* and *G. wardii*).

From field and herbarium observations, we consider *Gaultheria tetramera* to be conspecific with *G. semi-infera*. A substantial number of individuals on herbarium specimens that otherwise match the types of either *G. semi-infera* or *G. tetramera* exhibit both 4- and 5-merous flowers or fruit on the same branch. This observation was confirmed in the field, in which this polymorphism was clearly documented on a single individual growing along the road from Kongdang to Gongshan on the west side of the GLGS in the vicinity of GLGS 32380 (Fig. 36). Moreover, the individual showed several fruits with either three or six calyx lobes, and one even with two. Such variation was observed also on other plants in the vicinity. Within the GLGS, there is a definite preponderance for more elliptic and smaller leaves in Tengchong County, the area from which the type of *G. tetramera* was collected, and most of the individuals from there appear to be consistently 4-merous. Nonetheless, individuals with such leaves and/or the 4- and 5-merous condition can be found as far north as the Dulongjiang, and no distinct gaps in the variation of leaf morphology can be detected among the specimens identifiable to *G. semi-infera*/*G. tetramera* in association with either geography or other characters, including flower merosity. Populations from the Tengchong area can at most be considered a small-leaved phase within *G. semi-infera*, possibly associated with the volcanic soils that prevail in the region but not in the surrounding areas in which the species occurs.

SELECTED ILLUSTRATION.— T.Z. Xu, Fl. Xizang. 3:704 t. 282(4–7). 1986.

PHOTOGRAPHIC IMAGES.— Figures 35–36.

PHENOLOGY.— Fl. May–Jul, fr. Jul–Jan.

DISTRIBUTION AND HABITAT.— Subtropical evergreen broadleaf forests, deciduous broadleaf forests, coniferous forests, thickets, 1400–3400 m. In GLGS: CHINA. Xizang: Zayü Xian. Yunnan: Fugong Xian (Lishadi Xiang, Lumadeng Xiang, Shangpa Zheng), Gongshan Xian (Bingzhongluo Xiang, Cikai Zheng, Dulongjiang Xiang, Pengdang Xiang), Lianghe Xian, Longling Xian (Zhen'an Zheng), Lushui Xian (Luyobenzhou Xiang, Luzhang Zheng, Pianma Xiang), Tengchong Xian (Dongshan Xiang, Houqiao Zheng, Mingguang Xiang, Zhonghe Xiang), MYANMAR.



FIGURE 35. Flowering branchlet of *Gaultheria semi-infera*. Photo L. Zhou.



FIGURE 36. Fruit of *Gaultheria semi-infera*. Note fruit with four or five calyx lobes on same individual. Photo by P. Fritsch.

Kachin: Myitkyina District (Chipwi Township); Figure 37. Outside of GLGS: Xizang, Yunnan [Bhutan, India, Myanmar, Nepal].

CHINESE NAME.— 五雄白珠 *wu xiong bai zhu*

ADDITIONAL GAOLIGONG SHAN SPECIMENS EXAMINED: CHINA.

XIZANG: ZAYÜ XIAN. Hui Dong Qu, Bu la Du, 2900 m, 7 Sep 1991, *QX* 9998 (KUN); Ri Dong district, Shi la Du, 7 Sep 1991, *QX* 10015 (KUN).

YUNNAN: 1919, *F* 18805 (E, K); Mid W Yunnan, Nov 1925, *F* 27777 (E, K); *F* 29050 (E); *F* 29984 (E); *F* 30371 (E); between Tengyueh and Lungling, Oct 1922, *Rock* 7210 (A); same data, *Rock* 7238 (A); *Tsai* 57788 (A);

FUGONG XIAN. From Bijiang City downtown to Tou Dao Shui, 2000 m, 26 May 1978, *BE* 9 (KUN); La Bu Li, 2600, 7 Jul 1978, *BE* 794 (KUN); Che-tse-lo, 3200 m, 30 Aug 1938, *Tsai* 58323 (A, E); 9 Sep 1934, *Tsai* 58420 (A, E). Kong Dong La Bo Jing La Bu Luo River, 2800 m, 11 Jul 1978, *BE* 1006 (KUN); above forest logging camp ca. 15 km W of the Salween River cable car crossing, Yaping, 2600 m, 21 Oct 1996, *GLGS* 7887 (E, KUN); Kong Tong La Bu Jin, Gaoligongshan, 2000 m, 8 Jul 1978, *NE* 79-928 (KUN); Qian Mu Gu Lu, Aludeng, 2500–3000 m, 31 Jul 1979, *NE* 79-1666 (KUN); Guqian Team, Qiao Mi Gu Lu, 1700–2000 m, 9 Jun 1982, *QX* 7206 (KUN [2]); Pu Le Shang, 2700 m, 30 May 1979, *YM. Zhang* 307 (KUN [2]).

Lishadi Xiang. Yaduo Cun, vicinity of Shibali, N side of N fork of the Yamu He, E side of Gaoligong Shan, 2590 m, 4 Aug 2005, *GLGS* 26352 (CAS); Yaduo Cun, above Shibali, S side of N fork of the Yamu He, rd to Myanmar border at Yaping Yakou, E side of Gaoligong Shan, 2830 m, 6 Aug 2005, *GLGS* 26546 (CAS); Yaduo Cun, above Shibali to Myanmar border at Yaping Yakou, N side of N fork of the Yamu He, E side of Gaoligong Shan, 2750 m, 10 Aug 2005, *GLGS* 26907 (CAS); Yaduo Cun, above Shibali along N side of S fork of the Yamu He, E side of Gaoligong Shan, 2770 m, 15 Aug 2005, *GLGS* 28320 (CAS); Yaduo Cun, vicinity of Luodigoulu, N side of N fork of the Yamu He, E side of Gaoligong Shan, 2520 m, 16 Aug 2005, *GLGS* 28422 (CAS); same data, *GLGS* 28428 (CAS).

Lumadeng Xiang. Yaping Cun, vicinity of Shibali, S side of N fork of the Yamu He, E side of Gaoligong Shan, 2510 m, 16 Aug 2005, *GLGS* 28482 (CAS); Yaping Cun, below old Shibali, N side of S fork of the Yamu He, E side of Gaoligong Shan, 2150–2300 m, 1 Aug 2005, *GLGS* 28741 (CAS); same data, *GLGS* 28745 (CAS); Yaping Cun, below old Shibali, N side of S fork of the Yamu He, E side of Gaoligong Shan, 2040 m, 21 Aug 2005, *GLGS* 28780 (CAS); Yaping Cun, above old Shibali, N side of S fork of the Yamu He, E side of Gaoligong Shan, 2700 m, 21 Aug 2005, *GLGS* 28827 (CAS); same data, *GLGS* 28828 (CAS); Yaping Cun, rd above old Shibali, N side of S fork of the Yamu He, E side of Gaoligong Shan, 2540 m, 22 Aug 2005, *GLGS* 28854 (CAS); same data, *GLGS* 28865 (CAS).

Shangpa Zheng. 2500 m, 16 Sep 1933, *Tsai* 54254 (A, E); 2500 m, 19 Oct 1933, *Tsai* 54472 (A, KUN); 2300 m, 25 Oct 1933, *Tsai* 54938 (A, KUN); 2000 m, 20 Sep 1933, *Tsai* 56532 (A, E); 2000 m, 28 Oct 1934, *Tsai* 59026 (A). **GONGSHAN XIAN.** E slope of Gaoligong Shan, 1800–3510 m, 15 Jul 1983, *Q. Lin* 790977 (KUN); W slope of Gaoligong Shan, 2700 m, 15 Jul 1979, *Q. Lin* 790982 (KUN [2]); Da You to Ma Shi Ding, 1930–2500 m, 31 Jul 1979, *NE* 79-1891 (KUN). **Bingzhongluo Xiang.** Chang Pu Tong, 2300–2500 m, 6 Sep 1940, *Feng* 7543 (KUN); in regionis calide temperatae ad fluvium Lu-djiang (Salween) prope Tschamutong pteridietis graminosis ad vicum Bahan, 2600 m, 20 Apr 1916, *H. F. v. Handel-Mazzetti* 9027 (A, E, K); from Ma Tong to Bai Mang Xue Shan, 2500 m, 29 May 1960, *NT* 8825 (KUN); Mount Kenyichunpo and region of Cham-putong, Salween-Irawadi Watershed, 11000 ft., 1923, *Rock* 11230 (A); Si Chi Tong, 2800 m, Oct 1935, *Wang* 67423-A (A); same location, 2800 m, Oct 1935, *Wang* 67423 (KUN); Si Chi Tong, Salwin-Kiu Kiang divide, 2000 m, Oct 1935, *Wang* 67506 (A). **Cikai Zheng.** Hei Pu Shan, 19 Oct 1940, *Feng* 8600 (KUN [2]); track from Qiqi Forest Station SE toward Gongshan to main bridge over the Pa Le He, 1800–2000 m, 18 Sep 1991, *GLGS* 7248 (E); Qiqi Nature Reserve Station to track heading toward Dulongjiang, 2400 m, 16 Oct 1996, *GLGS* 7709 (E); Qiqi to Dongshaofang, 2730 m, 14 Oct 1996, *GLGS* 7732 (E, KUN); E side of Gaoligong Shan, along the Danzhu He, rd from Nujiang at Danzhu to the Myanmar border, 2750 m, 1 Jul 2000, *GLGS*

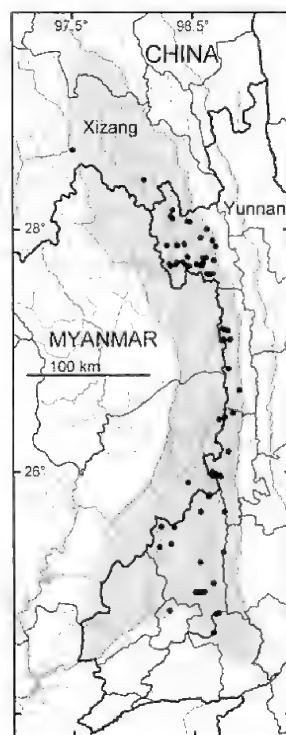


FIGURE 37. Distribution map of *Gaultheria semi-infera* in the GLGS region.

11839 (CAS, KUN); E side of Gaoligong Shan, vicinity of Daxue Cao waterfall, along the Danzhu He, rd from the Nujiang at Danzhu to Myanmar border, 2600 m, 3 Jul 2000, *GLGS 11939* (CAS, KUN); E side of Gaoligong Shan, above Daxue Cao waterfall, along the Danzhu He, rd from the Nujiang at Danzhu to the Myanmar border, 2500 m, 4 Jul 2000, *GLGS 11982* (CAS, KUN); E side of Gaoligong Shan, W of Gongshan and W of Qiqi, along the Pula He, trail to Dongshao Fang and Dulongjiang Valley, 2200 m, 10 Jul 2000, *GLGS 12245* (CAS, KUN); rd from Gongshan to Kongdang, E side of Gaoligong Shan, 2510 m, 10 Oct 2002, *GLGS 17129* (CAS, KUN); E side of Gaoligong Shan, rd from Danzhu to Myanmar border, 2700 m, 10 Nov 2004, *GLGS 22337* (CAS); same data, *GLGS 22343* (CAS); Danzhu Cun, S side of the Danzhu He ca. 8.5 direct km WSW of Danzhu, rd to Myanmar border, E side of Gaoligong Shan, 2550 m, 26 Aug 2006, *GLGS 34131* (CAS); Heiwadi Cun, vicinity of Dimupo, rd from Gongshan to Kongdang, ca. 6.4 direct km WNW of Gongshan, E side of Gaoligong Shan, 2380 m, 27 Aug 2006, *GLGS 34210* (CAS); vicinity of Dimupo, near Km 28, rd from Gongshan to Kongdang, ca. 8.5 direct km W of Gongshan, E side of Gaoligong Shan, 2700 m, 30 Aug 2006, *GLGS 34356* (CAS); trail from Qiqi to No. 12 Bridge, 2400–2600 m, 3 Jun 2006, *Lu 109* (CAS); hill behind Gongshan City, 2000 m, 11 Jun 1979, *NE 79-388* (KUN); Qiqi, 2000 m, 19 Jul 1982, *QX 8161* (KUN).

Dulongjiang Xiang. Second team, E slope of Dulongjiang, 1800 m, 29 May 1964, *Feng 24723* (KUN [2]); vicinity of Kongdang, E side of the Dulongjiang, 2600 m, 2 Jan 1991, *GLGS 1598* (CAS, KUN); Dan Dan He, 1700 m, 18 Jan 1991, *GLGS 3281* (KUN); Xue Ba La Ka, 2000 m, 20 Apr 1991, *GLGS 6173* (KUN [2]); along the Gamolai He ca. 3 km S of Bapo, E side of the Dulongjiang, 1460 m, 30 Oct 2004, *GLGS 21123* (CAS); W side of the Dulongjiang, vicinity of Xiongdang Pass ca. 1 km N of Dizhengdang (Lengdang) and ca. 23.5 direct km N of Kongdang, 2000 m, 29 Oct 2004, *GLGS 21406* (CAS); vicinity of Sandui campsite between Shigong Qiao and Xixiaofang, trail from Bapo to Gongshan via Qiqi, W side of Gaoligong Shan, 2500 m, 29 Oct 2004, *GLGS 21970* (CAS); along rd between Kongdang and Heipu Pass tunnel, new rd from Gongshan to Dulongjiang Valley, ca. 8.4 direct km E of Kongdang, W side of Gaoligong Shan, 2460 m, 15 Aug 2006, *GLGS 32380* (CAS); vicinity of Waluoban, W side of Dulongjiang Valley, ca. 3.1 direct km N of Maku and ca. 5.5 direct km NE of Myanmar border, 2750 m, 18 Aug 2006, *GLGS 32433* (CAS); at Maku Village, W side of Dulongjiang Valley, ca. 4.4 direct km NE of Myanmar border, 2250 m, 19 Aug 2006, *GLGS 32576* (CAS); ca. 11.5 direct km N of tunnel at the pass into Dulongjiang Valley, rd from Gongshan to Kongdang and ca. 27.5 direct km NW of Gongshan, W side of Gaoligong Shan, 2370 m, 6 Jan 2009, *GLGS 34411* (CAS); San Dui to Mieliwang, 2200–2600 m, 5 Jun 2006, *Lu 70* (CAS [2]); Dulongjiang to Gongshan, 1979, *NE 79-636* (KUN); Longyuan, 1900 m, 29 Aug 1982, *QX 9738* (KUN); Chingtinglaka, 2400 m, 28 Jul 1938, *Yü 19503* (A, E); upper Kiukiang Valley, Singelila, 2500 m, 5 Aug 1938, *Yü 19641* (A, E); E mtn. of Dulongjiang Valley, 2500 m, 13 Sep 1938, *Yü 20206* (A, E); Panbahlung, Salwin-Kiukiang divide, 3000 m, 22 Oct 1938, *Yü 20831* (A [2], KUN).

Pengdang Xiang. Jiwa, E side of Gaoligong Shan, rd from Gongshan to Bingzhongluo, 1458 m, 13 Apr 2002, *GLGS 14271* (CAS, KUN).

LIANGHE XIAN. Mang Gu Shan, 1400 m, 2 Oct 1979, *Kunming Station of Chinese Acad. Sci. 12977* (KUN).

LONGLING XIAN. 2400 m, 6 Jan 1934, *Tsai 54572* (A, E, KUN).

Zhen'an Zheng. 1800 m, 4 Dec 1958, *J. Chen 723* (KUN).

LUSHUI XIAN. N'maikha-Salween, 10000 ft., Jun 1919, *F 17984* (A, E, K); W hill of Yakou, 2950 m, 13 Sep 1996, *GLGS 7220* (KUN [4]); Yao Jia Ping, 2440 m, 25 Oct 1996, *GLGS 8040* (KUN); Yao Jia Ping, 2680 m, 26 Oct 1996, *GLGS 8120* (KUN); Yao Jia Ping, ca. 1 km along rd to Pianma, 2540 m, 28 Oct 1996, *GLGS 8210* (E); Yao Jia Ping, 2270 m, 28 Oct 1996, *GLGS 8252* (KUN); rd from Pianma to Liuku, W slope of Salween/Irrawaddy divide, 2400–2600 m, 5 Oct 1997, *GLGS 10048* (E, KUN); Km 62, rd between the Salween and Pianma, W side of Gaoligong Shan, 2690 m, 11 Oct 1998, *GLGS 10222* (CAS, E, KUN); rd between the Salween and Pianma, W side of Gaoligong Shan, 2630 m, 14 Oct 1998, *GLGS 10412* (CAS, KUN).

Luyobenzhou Xiang. Vicinity of Bifu Bridge, ca. 32.7 direct km S of Fugong City and ca. 7.7 direct km W of the Nujiang, E side of Gaoligong Shan, 2640 m, 1 May 2004, *GLGS 20834* [mistakenly recorded as Fugong Xian, Pihe Xiang on the label but all other data are correct] (CAS); E'ga Cun, forest rd at Km 35, E side of Gaoligong Shan, 3000 m, 6 Aug 2005, *GLGS 25674* (CAS).

Luzhang Zheng. Rd between Lushui and Pianma Yakou at Km 53 from turn off on Liuku-Fugong rd, E side of Gaoligong Shan, 2850 m, 15 Oct 2002, *GLGS 15970* (CAS, KUN); Pianma Yakou, 2200 m, 31 May 2006, *Lu 103* (CAS [4]).

Pianma Xiang. From Pianma to Wuzhong, 2100 m, 29 Jul 1978, *BE 1498* (KUN); Pianma Pass, 2100–2700 m, 11 Jul 1978, *BE 1607* (KUN); same locality, 2100–2700 m, 29 Jul 1978, *BE 1608* (KUN); Hpimaw, 7500 ft., 26 Jun 1919, *R.J. Farrer 1068* (E); 3000 m, 14 Sep 1996, *GLGS 7262* (KUN [3]); vicinity of Km 62, rd from Lushui to Pianma, W side of Gaoligong

Shan, 2790 m, 17 May 2005, *GLGS 23303* (CAS). **TENGCHONG XIAN.** Gan Lan Zai, 3 Dec 1934, *M. Chen 3556* (E); divide between the Shweli and Tengyueh Valley, 7000 ft., Aug 1912, *F 8757* (E, K); hills E of Tengyueh, 6500 ft., Jul 1912, *F 8786* (E); Shweli-Salween divide, 7000–8000 ft., Nov 1919, *F 9331* (E); same locality, 11000 ft., Oct 1919, *F 15986* (E, K); same locality, 7000 ft., Sep 1919, *F 18542* (E, K); hills around Tengyueh, 7000–9000 ft., Dec 1924, *F 26181* (E, K); Shweli-River drainage basin to summit of Shweli-Salween Watershed, E of Tengyueh, Nov 1922, *Rock 7692* (A); between the Salween and Irrawaddi, 1800–2000 m, Nov 1922, *Schneider 2606* (A, GH, K). **Dongshan Xiang.** Qingcaitang, old rd from Tengchong to Baoshan between Tengchong and the Longchuanjiang, 2070 m, 2 Nov 1998, *GLGS 11340* (CAS, E, KUN); *GLGS 11348* (CAS, E, KUN). **Houqiao Zheng (Guyong Zheng).** Vicinity of Gaoshidong in Guyong Linchang (forest farm), ca. 9.8 direct km ENE of Houqiao (Guyong), 2570 m, 27 May 2006, *GLGS 30663* (CAS); Danzha Cun, vicinity of Zhaobitan forest farm, ca. 26.5 direct km NNW of Houqiao (Guyong), 2630 m, 29 May 2006, *GLGS 30787* (CAS); Dan Zha, 2400 m, 17 Oct 1983, *Q. Lin 770689* (KUN); from Gu Yong to Dan Zhao, 29 May 1964, *Wu 6924* (KUN). **Mingguang Xiang.** Zizhi Cun, ca. 9.5 direct km NE of Zizhi, rd to Baduolin Yakou (the pass into Myanmar at border marker 8), Jiangao Shan, W side of Gaoligong Shan, 2750–2850 m, 19 May 2006, *GLGS 29239* (CAS); Zizhi Cun, rd from Zizhi to Baduolin Yakou (the pass into Myanmar at border marker 8), Jiangao Shan, W side of Gaoligong Shan, 2650 m, 20 May 2006, *GLGS 29289* (CAS); Zizhi Cun, Jiangao Shan, rd from Zizhi to Baduolin Yakou (pass at marker number 8 between China and Myanmar), W side of Gaoligong Shan, 2770 m, 23 May 2006, *GLGS 30509* (CAS); Zizhi Cun, Jiangao Shan, trail E of Baduolin Yakou (pass at marker 8 between China and Myanmar), W side of Gaoligong Shan, 3020 m, 23 May 2006, *GLGS 30532* (CAS). **Zhonghe Xiang.** Huan Xi Po, 2100 m, 8 Aug 1980, *S.H. Li 80-607* (KUN). **MYANMAR. KACHIN: MYITKYINA DISTRICT. Chipwi Township.** N'maikha-Salwin divide, 10000–11000 ft., Jun 1931, *F 29648* (E); Htawgaw, valley of Maung-chuang, Jalu country, 9000–10000 ft., 30 May 1914, *KW 1613* (E).

20. *Gaultheria sinensis* J. Anthony, Notes Roy. Bot. Gard. Edinburgh 18:19. 1933. TYPE.—CHINA. Xizang: Ka-gwr-pu, Mekong-Salwin divide, 28°25'N, 12000 ft., July 1917, *G. Forrest 14216* (holotype: E!; isotype: K!).

Gaultheria sinensis J. Anthony var. *major* Airy Shaw, Bull. Misc. Inform. Kew 1940:325. 1941 ["*maior*"]. TYPE.—CHINA. Yunnan: Kari Pass, Mekong-Yangtze divide, 27°40'N, 3300 m, August 1914, *G. Forrest 12938* (holotype: K!; isotypes: E!, BM!).

Gaultheria sinensis var. *crassifolia* Airy Shaw, Bull. Misc. Inform. Kew 1940:326. 1941. TYPE.—CHINA. Xizang: [Tsarong Xiang], Salwin-Kiu Chiang divide [Gaoligong Shan], 28°40'N, 98°15'E, October 1919, *G. Forrest 19286* (holotype: K!; isotype: E!).

Shrublets 3–15 cm tall, prostrate. Branchlets elongate, terete, ferrugineous-, red-, light brown- or black-uncinate-setulose and often white-puberulent. Petiole 0.4–2 mm, abaxially glabrous or sparsely setulose, adaxially glabrous or white-puberulent; leaf blade elliptic to oblanceolate, 5.5–14 × 3–7 mm, gradually smaller along stems toward both ends of each year's growth, 1.4–2.6 × as long as wide, coriaceous to subcoriaceous, abaxially dull light green to light brown with narrow glossy edge and sparsely setulose at least along midvein on at least some leaves, adaxially ± glossy green to brown and glabrous or white-puberulent proximally along midvein, midvein abaxially raised to occasionally prominent and adaxially sulcate to occasionally planar, secondary veins (when visible) 2–5 on each side of midvein, secondary and tertiary veins obscure or occasionally distinct, base cuneate to subrounded, margin serrulate, with 4–14 setulose-tipped teeth per side, revolute to occasionally planar, apex acute to rounded. Inflorescences axillary, 6–9 mm, 1-flowered; bracts absent. Pedicel 1.5–5 mm, glabrous; bracteoles 2, apical, broadly ovate to orbicular, not keeled, 1.8–4 × 1.8–3 mm, persistent, glabrous, margin entire, apex broadly obtuse to rounded. Calyx 2.7–4 mm; lobes (4)5, broadly ovate-deltoid, 1.5–2.3 × 1.8–2.5 mm, mostly overlapping at base, outside glabrous, inside glabrous or pubescent, margin entire or distally slightly erose and

often distally ciliolate, apex acute to obtuse. Corolla white to pink, broadly urceolate to campanulate, 3–4.5 × 3–5 mm, glabrous on both sides; lobes (4)5, oblong to deltoid-oblong, 1–2 mm. Stamens 8–10; filaments 0.6–1.2 mm, dilated medially, sides convex-curved, glabrous; anthers 0.6–0.9 mm, 4-awned; awns 0.2–0.6 mm. Ovary glabrous; style ca. 1.5 mm. Calyx at fruiting blue, fleshy; lobes incurved, narrowly pale-edged. Capsule 6–8 mm in diam., glabrous.

Gaultheria sinensis vars. *major* and *crassifolia* were described by Airy Shaw (1941) on the basis of fruiting material only. These varieties were distinguished from the nominate variety on the basis of leaf size and thickness, respectively. Because both of these characters appear to vary continuously in *G. sinensis*, we are resigned to agree with Fang and Stevens (2005) in not recognizing these varieties, but stress the need for the collection of flowering specimens of *G. sinensis* with unusually large or thick leaves to provide further insight into the taxonomic status of these varieties.

See also comments under *Gaultheria hypochlora*.

SELECTED ILLUSTRATIONS.— See comments under *Gaultheria hypochlora*.

PHOTOGRAPHIC IMAGE.— Figure 38.

PHENOLOGY.— Fl. May–Jul, fr. Jun–Oct.

DISTRIBUTION AND HABITAT.— Subtropical evergreen broadleaf forests, deciduous forests, coniferous forests, grasslands, meadows; 2500–4200 m. In GLGS: CHINA. Xizang: Zayü Xian (Tsarong Xiang). Yunnan: Fugong Xian (Lishadi Xiang, Lumadeng Xiang, Yaping Xiang), Gongshan Xian (Bingzhongluo Xiang, Cikai Zheng, Dulongjiang Xiang), Lushui Xian (Pianma Xiang), MYANMAR. Kachin: Myitkyina District (Hsawlaw Township); Figure 39. Outside of GLGS: Sichuan, Xizang, Yunnan [Bhutan, India, Myanmar].

CHINESE NAME.— 华白珠 *hua bai zhu*

ADDITIONAL GAOLIGONG SHAN SPECIMENS EXAMINED: CHINA. XIZANG: ZAYÜ XIAN. Salwin-Kiu Chiang divide, 13000 ft., Aug 1921, *F 20040* (A, E, K, P); Deyang La, 13000 ft., 6 Jun 1947, *F. Ludlow & G. Sherriff 15158* (A, E); Ri Dong Qu, 4200 m, 8 Sep 1982, *QX 10107* (KUN). YUNNAN: FUGONG XIAN. Che-tse-luo, 4000 m, 25 Aug 1934, *Tsai 58172* (A, KUN). Da you to Gua Didi, 3350 m, 1 Aug 1970, *Q. Lin 792037* (KUN). Lishadi Xiang. Between Shibali Logging Station and Yaping Pass, ca. 4.1 km W of



FIGURE 38. Fruiting plant of *Gaultheria sinensis*. Photo by L. Zhou.

Shibali, rd from the Nujiang to Yaping Pass, E side of Gaoligong Shan, 3007 m, 2 May 2004, *GLGS 20140* (CAS); Yaduo Cun, above Shibali to Myanmar border at Yaping Yakou, N side of N fork of the Yamu He, E side of Gaoligong Shan, 2750 m, 10 Aug 2005, *GLGS 26921* (CAS). **Lumadeng Xiang**, Yaping Cun, S side of N fork of the Yamu He above Shibali, E side of Gaoligong Shan, 3050 m, 8 Aug 2005, *GLGS 26754* (CAS); Yaping Cun, below Amero Pass along the rd back down to confluence of N and S fork of the Yamu He, E side of Gaoligong Shan, 3120 m, 13 Aug 2005, *GLGS 27161* (CAS); Yaping Cun, vicinity of Shibali, S side of N fork of the Yamu He, E side of Gaoligong Shan, 2510 m, 16 Aug 2005, *GLGS 28501* (CAS); Ou Lu Di, 3800 m, 28 May 1982, *QX 6998* (KUN). **Yaping Xiang**, Vicinity of Yaping Pass near the Myanmar border, E side of Gaoligong Shan, 3620 m, 5 May 2004, *GLGS 20969* (CAS); vicinity of Yaping Pass near the Myanmar border, E side of Gaoligong Shan, 3700 m, 5 May 2004, *GLGS 20975* (CAS). **GONGSHAN XIAN**. **Bingzhongluo Xiang**, Chang Pu Tong, 3500–3700 m, 10 Jul 1940, *Feng 7675* p.p. (KUN); ca. 3 direct km SSW of Gawagapu Mtn. and ca. 16 direct km WSW of Bingzhongluo in the next basin to the E of Chukuai Lake, E side of Gaoligong Shan, 3770 m, 29 Aug 2006, *GLGS 31589* (CAS); ca. 2.1 direct km S of Gawagapu Mtn. and ca. 15.2 direct km WSW of Bingzhongluo in the next basin to the E of Chukuai Lake, E side of Gaoligong Shan, 4000 m, 28 Aug 2006, *GLGS 32809* (CAS); Soo-roo la, Champutong, 3000 m, Sep 1935, *Wang 66678* p.p. (A, KUN); Chang Pu Tong, 3000 m, Oct 1935, *Wang 67099* (A, KUN). **Cikai Zheng**, E side of Gaoligong Shan, W of Gongshan, along the Pula He, trail from Qiqi to Dongshao Fang and Dulongjiang Valley, 2770–3050 m, 15 Jul 2000, *GLGS 12551* (CAS, KUN); E side of Gaoligong Shan, W of Gongshan, along the Pula He, trail from No. 12 Bridge to Dongshaofang and Dulongjiang Valley, 2900 m, 1 May 2002, *GLGS 14794* (CAS); ca. 1.2 direct km SSE of Heipu Pass tunnel on new rd from Gongshan to the Dulongjiang Valley, E side of Gaoligong Shan, 3350 m, 13 Aug 2006, *GLGS 32150* (CAS); same data, *GLGS 32170* (CAS); E slope of Gaoligongshan, 3600 m, 26 Jul 1982, *QX 8726* (KUN). **Dulongjiang Xiang**, Sandui, W side of Gaoligong Shan, along Gamolai He on trail from Xishaofang to Bapo, 2570 m, 17 Jul 2002, *GLGS 15033* (CAS, KUN); E side of pass of rd from Gongshan to Kongdang, W side of Gaoligong Shan near crest of range, 3670 m, 5 Oct 2002, *GLGS 17007* p.p. (CAS, KUN); from Gongshan to Dulongjiang, 2700 m, 9 May 1978, *NE 79-86* (KUN); Gongshan Yakou to Dulongjiang, 1979, *NE 79-558* (KUN); Parolaka, 3500 m, 13 Oct 1938, *Yü 20683* (A, E). **LUSHUI XIAN**, Wang Zhuan He, close to Da He, 3100 m, 30 Jun 1969, *Wu 7333* (KUN). **Pianma Xiang**, W slope of Pianma Yakou, Fengxue Yakou, 3000 m, 27 Jul 1978, *BE 1351A* (KUN); Pianma Yakou, 3300 m, 8 Jun 2006, *Lu 21* (CAS). **MYANMAR. KACHIN: MYITKYINA DISTRICT. Hsawlaw Township**, Shing Hong Pass, 10500 ft., 16 Jun 1920, *R.J. Farrer 1622* (E).

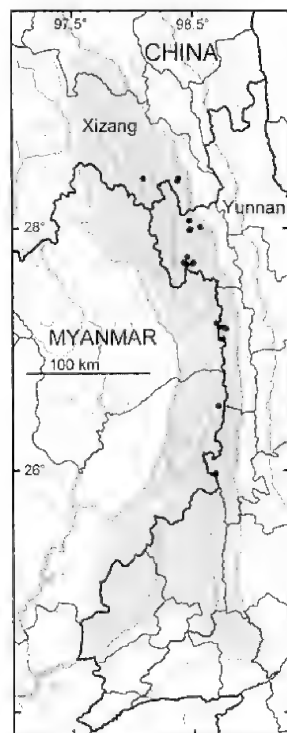


FIGURE 39. Distribution map of *Gaultheria sinensis* in the GLGS region.

21. *Gaultheria suborbicularis* W.W. Smith, Notes Roy. Bot. Gard. Edinburgh 8:186. 1914. *Chiogenes suborbicularis* (W.W. Smith) Ching ex T.Z. Xu, Acta Bot. Yunnan. 6:40. 1984. TYPE.—CHINA. Yunnan: western Yunnan [Gongshan Xian], between Yunnan and E Tibet [Gaoligong Shan], 15000 ft., *F. Kingdon Ward 850* (lectotype, here designated: E Barcode No. 231017!; isolectotype: E Barcode No. 231018!).

The type material of *Gaultheria suborbicularis* was indicated as E in the protologue, but there are two sheets of the type material at E, both with the written words “Type.” We have selected the E sheet barcoded as 231017 as lectotype because it has more material than the other sheet (231018) and has better flowering material. In addition, it bears a tag labeled “Type specimen” whereas this does not occur on 231018.

Shrublets, prostrate. Branchlets elongate and long-trailing, terete to irregularly ridged, wiry, densely tawny-, dull orange-, or ferrugineous-ascending setose-villous and white-puberulent. Petiole 0.5–0.8 mm, glabrous or setulose; leaf blade broadly elliptic, suborbicular, or rarely elliptic, 4–8 × 3–5.5 mm, gradually smaller along stems toward both ends of each year's growth, 1.2–1.8 × as long as wide, coriaceous, abaxially greenish brown to brown and tawny- to ferrugineous-appressed-setose, adaxially glabrous, midvein abaxially planar to raised and adaxially planar to impressed, secondary veins abaxially obscure and adaxially impressed or obscure, tertiary veins obscure on both surfaces, base rounded to subcordate, margin obscurely serrulate, with 10–13 setose-tipped teeth per side, revolute, apex obtuse to rounded. Inflorescences axillary, 4–5 mm, 1-flowered; bracts absent. Pedicel slender, 1–2 mm, glabrous; bracteoles apical, ovate to subrhombic, slightly keeled, 1.5–2 × 1.5–2.1 mm, persistent, glabrous, margin entire, apex acuminate. Calyx 1.7–2.7 mm; lobes 4, ovate-deltoid, 1.4–2 × 1–2 mm, glabrous, margin entire, apex shortly acuminate. Corolla rose, purplish, or sometimes white, campanulate, 2–3 × ca. 3 mm, glabrous; lobes 4, deltoid, 1–1.8 mm. Stamens 4–7; filaments ca. 0.6 mm, dilated medially, sides convex-curved, glabrous; anthers 0.3–0.5 mm, awns 0.1–0.2 mm. Ovary glabrous; style 0.6–0.8 mm, glabrous. Calyx at fruiting red, fleshy; lobes incurved, not pale-edged. Capsule 3–4 mm in diam., glabrous.

SELECTED ILLUSTRATIONS.— R.C. Fang, *Fl. Reipubl. Popularis Sin.* 57(3):70 t. 20(1–7). 1991; G.H. Zhu & L.B. Zhang, eds. *Fl. China* III. 14: t. 665(1–7). 2006.

PHOTOGRAPHIC IMAGE.— Figure 40.

PHENOLOGY.— Fl. May–Jul, fr. Aug–Oct.

DISTRIBUTION AND HABITAT.— Forest understories, thickets, grassy slopes, on rocks; 3000–4600 m. In GLGS: CHINA. Xizang: Zayü Xian (Tsarong Xiang). Yunnan: Gongshan Xian (Bingzhongluo Xiang, Cikai Zheng, Dulongjiang Xiang); Figure 41. Outside of GLGS: Yunnan.



FIGURE 40. Fruiting plants of *Gaultheria suborbicularis*. Photo by L. Lu.

CHINESE NAME.—伏地白珠 *fu di bai zhu*

ADDITIONAL GAOLIGONG SHAN SPECIMENS EXAMINED: CHINA.

XIZANG: ZAYÜ XIAN. Ri Dong Qu, 3800 m, 1 Sep 1935, *QX 10128* (KUN). **Tsarong Xiang.** Salween-Kiu Chiang divide, 15000 ft., Jul 1921, *F 19888* (E); same locality, 15000 ft., *F 20267* (E, P [2]); same locality, 15000 ft., 22 Apr 1955, *F 20872* (E); S Tsarong, Oct 1922, *F 22844* (E). **YUNNAN: GONGSHAN XIAN.** Bingzhongluo Xiang. Soo-roo la, Champutong, 3000 m, Sep 1935, *Wang 66678* p.p. (A, KUN). **Cikai Zheng.** Dong Shao Fang, 3300 m, 11 May 1979, *NE 79-134* (KUN). **Dulongjiang Xiang.** Kong Mu Da Dui, 3500–3800 m, 17 Jul 1979, *Q. Lin 791043* (KUN); upper Kiukiang Valley, Chuherton, 3100 m, 6 Aug 1936, *Yü 19684* (A, E, KUN); Salwin-Kiukiang divide, Netahtzu, 3600 m, 17 Oct 1938, *Yü 20737* (A, E, KUN).

22. *Gaultheria thymifolia* Stapf ex Airy Shaw, Bull. Misc. Inform. Kew 1940:322. 1941. TYPE.—MYANMAR. Kachin: [Myitkyina District. Chipwi Township], NE Upper Burma, western flank of the N'maika-Salwin divide [Gaoligong Shan], 26°24'N, 98°48'E, 3300 m, June 1925, *G. Forrest 26867* (holotype: K!; isotypes: BM!, E!).

Shrublets 2.5–10 cm tall, mat-forming, decumbent. Branchlets elongate, terete, densely red-, ferrugineous-, brown-, or black-uncinate-setulose and often white-puberulent. Petiole 0.2–0.8 mm, glabrous or occasionally adaxially white-puberulent; leaf blade linear-ob lanceolate to less often oblanceolate, 5–8.5 × 1.3–2.5 mm, gradually smaller along stems toward both ends of each year's growth, 2.4–6.2 × as long as wide, coriaceous, abaxially dull light green to light brown with glossy edge, adaxially glossy green to brown, both surfaces glabrous or occasionally adaxially puberulent along midvein toward base, midvein abaxially prominent and adaxially sulcate, secondary and tertiary veins obscure, base cuneate, margin serrate, with 3–8 setulose-tipped teeth per side, planar to slightly revolute, apex acute to obtuse. Inflorescences axillary, 5–7 mm, 1-flowered; bracts absent. Pedicel 1.5–3 mm, glabrous; bracteoles 2, apical, broadly ovate, not keeled, 1–1.8 × 1–2 mm, persistent, glabrous, margin entire, apex broadly obtuse. Calyx 3–3.5 mm; lobes 5, ovate-deltoid, 2–3 × 1.3–1.8 mm, not overlapping at base, glabrous, margin entire, apex acuminate. Corolla white to maroon, campanulate, 3–4 × 3–5 mm, glabrous on both sides; lobes 5, deltoid-oblong, 1–2(–2.5) mm. Stamens 10; filaments 0.7–1 mm, gradually or ± abruptly dilated from apex, glabrous; anthers 0.6–1 mm, 4-awned; awns 0.2–0.3 mm. Ovary glabrous; style ca. 1.5 mm, glabrous. Calyx at fruiting white to occasionally pink, fleshy; lobes incurved, narrowly pale-edged. Capsule 3–6 mm in diam., glabrous.

Gaultheria thymifolia has until now been considered a species solely of Myanmar. Most specimens of this species from China have been previously identified as *G. cardiosepala*, a species clearly distinguishable from *G. thymifolia* by leaves with longer internodes, an urceolate corolla (versus campanulate) with smaller lobes (0.6–0.8 mm versus 1–2.5 mm), and larger size of several features (stature, leaf blades, anther awns, and style), as specified in our key.

ILLUSTRATIONS.—None known to us.

PHOTOGRAPHIC IMAGE.—Figure 42.

PHENOLOGY.—Fl. Jun–Jul, Oct, fr. Aug–Oct.

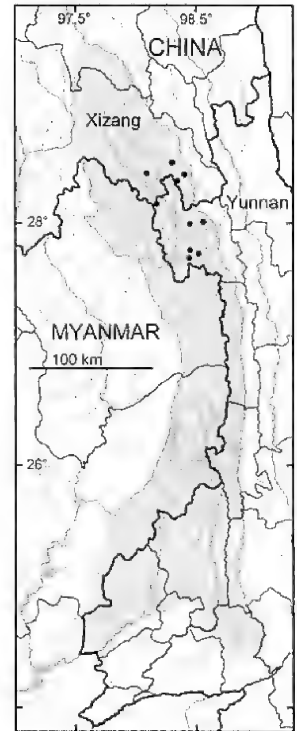


FIGURE 41. Distribution map of *Gaultheria suborbicularis* in the GLGS region.

DISTRIBUTION AND HABITAT.— Grasslands, meadows, open slopes, rocky places; 2800–3900 m. In GLGS: CHINA. Xizang (Zayü Xian) Yunnan: Gongshan Xian (Bingzhongluo Xiang, Cikai Zheng, Dulongjiang Xiang), Tengchong Xian, MYANMAR. Kachin: Myitkyina District (Chipwi Township, Hsawlaw Township, Waingmaw Township), Putao District (Nogmung Township); Figure 43. Outside of GLGS: Myanmar.

CHINESE NAME.— 细叶白珠 (新拟) xi ye bai zhu

ADDITIONAL GAOLIGONG SHAN SPECIMENS EXAMINED: CHINA. XIZANG: ZAYÜ

XIAN. Prope fines Tibeto-Burmanicas inter fluvios Lu-djiang (Salween) et Djiou-Jiang (Irrawadi orient.

Super.), 3000–3150 m, 9 Jul 1916, *H.F. v. Handel-Mazzetti* 9441 (A). YUNNAN: GONGSHAN XIAN. Bingzhongluo Xiang. Ca. 2.6 direct km SSW of Gawagapu Mtn. and ca. 15.5 direct km WSW of Bingzhongluo in the next basin E of Chukuai Lake, E side of Gaoligong Shan, 3880 m, 25 Aug 2006, GLGS 31446 (CAS); Mt. Kenyichunpo and region of Champutong, Salween-Irrawadi Watershed, 1923, *Rock* 10252 (A). Cikai Zheng. Hei Pu Shan, 13 Oct 1940, *Feng* 8417 (KUN). Dulongjiang Xiang. Gongshan Yakou to Dulongjiang, 1979, *NE* 79-714 (KUN); W of Chang Pu Tong, 2800 m, Oct 1935, *Wang* 67194 (A, KUN); Salween-Kiu Chiang divide, Parolaka, 3300 m, 10 Oct 1938, *Yü* 20613 (A, KUN); Salween-Kiu Chiang divide, Panbahlung, 3800 m, 21 Oct 1938, *Yü* 20821 (A, E, KUN). TENGCHONG XIAN. The seventh district, 1 Jul 1963, *J.S. Yang & X.N. Wang* 63-1351 (KUN). MYANMAR. KACHIN: MYITKYINA DISTRICT. Hsawlaw Township. Chevochi Pass, 11800 ft., 24 Sep 1947, *R.J. Farrer* 1677 (E). Waingmaw Township. advance base, Seinghku Wang, 10000–11000 ft., 5 Jun 1926, *KW* 6849 (K); PUTAO DISTRICT. Nogmung Township. Adung Valley, 12000–13000 ft., 15 Jun 1931, *KW* 9639 p.p. (A).

23. *Gaultheria trichophylla* Royle, Ill. Bot. Himal. Mts. 260. 1835. *Brossaea trichophylla* (Royle) O. Kuntze, Revis. Gen. Pl. 2: 387. 1891. TYPE.— INDIA. Jammu and Kashmir: Kishtwar, 10000 ft., *T. Thomson s.n.* (holotype: LIV; isotype: K!).

Gaultheria trichophylla Royle var. *obovata* Airy Shaw, Bull. Misc. Inform. Kew 1940:324. 1941. TYPE.— MYANMAR. Kachin: Upper Burma [Myitkyina District. Waingmaw Township], Seinghku Wang [Gaoligong Shan], 28°8'N, 97°24'E, 11000 ft., 17 June 1926, *F. Kingdon Ward* 6944 (holotype: K!).

Gaultheria minuta Merrill, Brittonia 4:152. 1941. TYPE.— MYANMAR. Kachin: [Putao District. Nogmung Township], Adung Valley [Gaoligong Shan], 28°20'N, 97°45'E, 25 June 1931, 12500 ft., *F. Kingdon Ward* 9701 (holotype: NY; isotype: A!, photograph of A in K!).

Gaultheria nana C.Y. Wu & T.Z. Xu, Acta Bot. Yunnan. 3:432. 1981. TYPE.— CHINA. Xizang: Dingjie Xian, Qinghai-Xizang Expedition 5534 (holotype: KUN!).



FIGURE 42. Fruit of *Gaultheria thymifolia*. Photo by D. Lin.

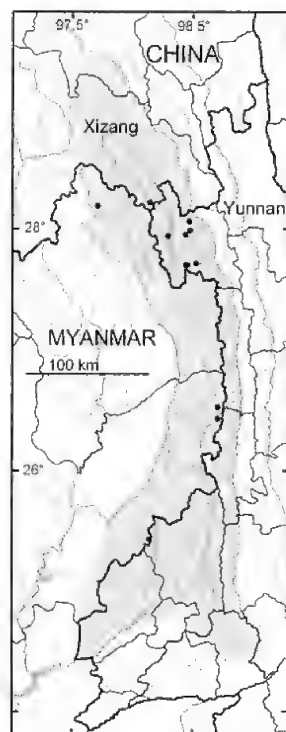


FIGURE 43. Distribution map of *Gaultheria thymifolia* in the GLGS region.

Shrublets 7.5–15 cm tall, prostrate to decumbent. Branchlets elongate, terete, ferrugineous-, red-, light brown-, or black-villous-setose and white-puberulent. Petiole 0.4–1.5 mm, abaxially glabrous or occasionally villous-setose, adaxially glabrous or white-puberulent; leaf blade narrowly to broadly elliptic, oblong-elliptic, ovate, or slightly obovate, $3\text{--}14 \times 2\text{--}6$ mm, gradually smaller along stems toward both ends of each year's growth, $1.5\text{--}2(-3.7) \times$ as long as wide, subcoriaceous to coriaceous, abaxially dull light green to light brown with narrow glossy edge and sparsely villous-setose at least along midvein on at least some leaves or occasionally all glabrous, adaxially glossy green to brown and glabrous or white-puberulent proximally along midvein, midvein abaxially raised to prominent and adaxially sulcate, secondary and tertiary veins distinct or occasionally obscure on both surfaces, secondary veins (when visible) 2–4 on each side of midvein, base cuneate to subrounded, margin serrulate with 4–14 villous-setose-tipped teeth per side, planar to slightly revolute, apex acute to subrounded. Inflorescences axillary, 6–8 mm, 1-flowered; bracts absent. Pedicel 1.5–3 mm, glabrous or white-puberulent; bracteoles 2, apical, broadly ovate to orbicular, not keeled, $1.2\text{--}2.5 \times 1.3\text{--}2.4$ mm, persistent, glabrous, margin entire, apex obtuse to rounded. Calyx 2.8–3.6 mm; lobes 5, ovate-deltoid to oblong-deltoid, $1.6\text{--}3 \times 1.4\text{--}2.3$ mm, mostly not overlapping at base, glabrous, margin entire, apex acute to subrounded. Corolla white to red, campanulate, $3.5\text{--}5.5 \times 3.5\text{--}7$ mm, glabrous on both sides; lobes 5, oblong to occasionally deltoid-oblong, 1.8–2.8 mm. Stamens 10; filaments 1–1.2 mm, gradually dilated medially or submedially from apex, glabrous; anthers 0.7–1 mm, 2- or 4-awned; awns 0.3–0.9 mm, occasionally bifid when 2-awned. Ovary glabrous; style 2–2.5 mm, glabrous. Calyx at fruiting blue, fleshy; lobes incurved to erect, narrowly pale-edged. Capsule 3–7 mm in diam., glabrous.

Gaultheria trichophylla is variable in leaf size and shape, habit, number of awns on the anthers, and other characters. We have chosen to recognize a single variable species without infraspecific taxa. Two other taxa with types collected outside the GLGS that might best be considered synonyms of *G. trichophylla* are *G. t.* var. *tetracme* Airy Shaw of Sichuan Province and *G. sinensis* J. Anthony var. *layaensis* S.J. Rae & D.G. Long of Bhutan. These taxa share with the other material comprising *G. trichophylla* villous-setose-tipped teeth on the leaf blade margin, a character not present in any other member of series *Trichophyllae*. *Gaultheria t.* var. *tetracme* and *G. s.* var. *layaensis* were separated from *G. trichophylla* partly through their four-awned anthers, but the number of awns per anther varies between two and four throughout the range of *G. trichophylla* and occasionally when the anthers are two-awned they are forked at the apex, suggesting reduction of two awns on each theca into a single awn via fusion. The other characters that reportedly distinguish these species, such as leaf size, shape, and thickness, all appear to be variable and continuous, with no correlated morphological gaps, but further study of this species throughout its range is warranted.

We have elevated *Gaultheria trichophylla* var. *eciliata* to species status in the present work (see discussion under *G. eciliata*).

SELECTED ILLUSTRATION.—T.Z. Xu, Fl. Xizang, 3:694 t. 277(2). 1986.

PHENOLOGY.—Fl. May–Jul, fr. Jul–Sep.

DISTRIBUTION AND HABITAT.—Montane grasslands, meadows,

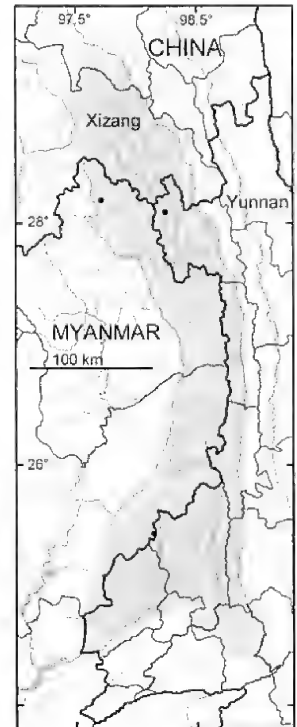


FIGURE 44. Distribution map of *Gaultheria trichophylla* in the GLGS region.

rocky places; 3300–4200 m. In GLGS: CHINA. Yunnan: Gongshan Xian (Dulongjiang Xiang), MYANMAR. Kachin: Myitkyina District (Waingmaw Township), Putao District (Nogmung Township); Figure 44. Outside of GLGS: Sichuan, Xizang, Yunnan [Bhutan, India, Nepal].

CHINESE NAME.—刺毛白珠 *ci mao bai zhu*

ADDITIONAL GAOLIGONG SHAN SPECIMENS EXAMINED: CHINA. YUNNAN: GONGSHAN XIAN. Dulongjiang Xiang, Chialahmuto, 3600–4000 m, 7 Aug 1938, *Yü 19732* (A, E). MYANMAR. KACHIN: PUTAO DISTRICT. Nogmung Township. Adung Valley, 12000–13000 ft., 15 Jun 1931, *KW 9639* p.p. (A).

24. *Gaultheria wardii* C. Marquand & Airy Shaw, J. Linn. Soc., Bot. 48:198. 1929. TYPE.—CHINA. Xizang: Tong-kyuk, 9000 ft., 10 August 1924, *F. Kingdon Ward 6071* (holotype: K!).

Gaultheria trichoclada C.Y. Wu, Acta Bot. Yunnan. 3:424. 1981. TYPE.—CHINA. Xizang: Bomi, *P.C. Tsoong 6185* (holotype: PE).

Gaultheria wardii C. Marquand & Airy Shaw var. *elongata* R.C. Fang, Novon 9:174. 1999. TYPE.—CHINA. Yunnan: Gongshan Xian [Gaoligong Shan], 2000 m, 28 July 1982, *Qinghai-Xizang Expedition 8858* (holotype: KUN; isotypes: KUN!, PE).

Shrubs 0.5–2.5 m tall, erect to arching. Branchlets elongate, terete, densely gray-, tawny-, brown-, or ferruginous-ascending-setose-hirsute and usually white-puberulent. Petiole 1–3 mm, setose-hirsute; leaf blade lanceolate to oblong-lanceolate, 3–7.5 × 1.1–2.5 cm, 2.2–4.6 × as long as wide, subcoriaceous, abaxially green and ferruginous-villous-hirsute, adaxially pustulate and glabrous or villous-hirsute to hirtellous, midvein abaxially prominent and adaxially narrowly sulcate, secondary veins 3 or 4 on each side of midvein, arising along midvein with proximal veins becoming faint or anastomosing before reaching apex, abaxially prominent, adaxially planar to impressed, tertiary veins abaxially raised or obscure and adaxially planar to impressed, base subrounded, subtruncate, subcordate, or rarely cuneate, margin denticulate, with 11–21 teeth per side, revolute, apex acute to shortly acuminate. Inflorescences axillary and terminal, rather dense racemes, 1.7–2.5 cm, 4–18-flowered; rachis slender, white-villulose or ferruginous-villous-setose or both; bracts rhombic-lanceolate to linear-lanceolate, not keeled, 4–6 × 0.6–2 mm, smaller distally along inflorescence, persistent, outside glabrous, puberulent, or setulose, inside glabrous or white-puberulent, margin ciliate and occasionally also setulose, apex long recurved acuminate. Pedicel 3–7 mm, white-puberulent or setose or both; bracteoles ± medial, linear-lanceolate to linear, 2–3.5 × 0.3–1 mm, otherwise similar to bracts. Calyx 2.5–3 mm; lobes 5, lanceolate-deltoid, 2.2–2.6 × 0.9–1.2 mm, glabrous or sparsely white-villulose on both sides, margin ciliate or entire, apex acuminate. Corolla white, urceolate, 3.5–4 × 3.5–4.5 mm, glabrous; lobes 5, oblong, 0.4–0.5 mm. Stamens 10; filaments 1–1.5 mm, gradually dilated submedially from apex, glabrous; anthers 0.7–1 mm, awns 0.4–0.5 mm. Ovary densely white-pilose; style 1.5–2 mm, proximally strigose. Calyx at fruiting blue to black, thin to somewhat fleshy, frequently glaucous; lobes erect, not pale-edged. Capsule 4–6 mm in diam., pilulose.

In the treatment of *Gaultheria* for *Flora of China*, Fang and Stevens (2005) recognized *G. wardii* var. *elongata* based on a longer rachis (2.5–3.5 cm versus 1–3 cm), glabrous calyx (versus densely pubescent), and abaxially subglabrous bracts and bracteoles (versus densely pubescent). We have observed a specimen with elongate infructescences, glabrous calyx lobes, and abaxially moderately densely setulose and puberulent bracts and bracteoles (*GLGS 1087*), and another with compact inflorescences (< 2.5 cm), glabrous calyx lobes, and densely puberulent (and sparsely setulose) bracts and bracteoles (*H. Li et al. 7167*). The inflorescence length character used to delimit varieties is difficult to assess because the type of the species is in flower whereas that of

the variety is in fruit, and the inflorescences of *G. wardii* usually elongate during development. Nonetheless, the length of the inflorescence from our measurements varies narrowly but continuously from 1.7 to 2.5 cm. The geographic range of var. *wardii* stated in Fang and Stevens (2005; Gongshan Co., northern India, and Myanmar) completely overlaps that of var. *elongata* (Gongshan Co.). The overlap in the inflorescence length combined with our observations indicates to us that these entities are not sufficiently distinct to warrant recognition.

SELECTED ILLUSTRATIONS.— R.C. Fang, *Fl. Reipubl. Popularis Sin.* 57(3):48 t. 15(1–5). 1991; G.H. Zhu & L.B. Zhang, eds. *Fl. China* III. 14: t. 655(1–5). 2006.

PHOTOGRAPHIC IMAGE.— Figure 45.

PHENOLOGY.— Fl. July, fr. Oct–Feb.

DISTRIBUTION AND HABITAT.— Subtropical evergreen broadleaf forests, thickets; 1300–2600 m. In GLGS: CHINA. Xizang: Zayü Xian. Yunnan: Gongshan Xian (Cikai Zheng, Dulongjiang Xiang); Figure 46. Outside of GLGS: Xizang [India, Myanmar].

CHINESE NAME.— 西藏白珠 *xi zang bai zhu*

ADDITIONAL GAOLIGONG SHAN SPECIMENS EXAMINED: CHINA. XIZANG: ZAYÜ XIAN. Hills opposite the city. 2600 m, 18 Jun 1983, *QX 73-187* (KUN). YUNNAN: GONGSHAN XIAN. Cikai Zheng. E side of Gaoligong Shan, W of Gongshan, along a branch of the Pula He, W of the Rizhidi Bridge, trail from Qiqi to Dongshao Fang and the Dulongjiang Valley, 2100–2200 m, 11 Jul 2000, *GLGS 12295* (CAS, KUN). **Dulongjiang Xiang.** Vicinity of Meiliwang, trail from Bapo to Gongshan on E side of the Dulongjiang, 1600 m, 23 Nov 1990, *GLGS 826* (CAS); vicinity of Maku, S region of the Dulongjiang Valley, W side of the Dulongjiang, 1780 m, 15 Dec 1990, *GLGS 1087* (CAS); vicinity of the primary school, ca. 2 km N of Bapo,



FIGURE 45. Branchlets of *Gaultheria wardii* with immature fruit. Photo by P. Fritsch.

E side of the Dulongjiang, 1330 m, 29 Dec 1990, *GLGS 1368* (CAS); along the Gamolai He, trail from Bapo to Gongshan on E side of the Dulongjiang, 1400 m, 30 Dec 1990, *GLGS 1441* (CAS); Mei Li Wang, 1800 m, 5 Jan 1991, *GLGS 1608* (KUN); Mei Li Wang, 1800 m, 10 Jan 1991, *GLGS 1941* (KUN); Dan Dang He, 1400 m, 17 Jan 1991, *GLGS 3210* (KUN); Ma Ku, 1850 m, 7 Mar 1991, *GLGS 4255* (KUN); Mei Li Wang, 1800 m, 21 May 1991, *GLGS 6981* (KUN); ca. 0.6 km NW of Meiliwang, trail between Bapo and Xixiaofang on trail from Bapo to Gongshan via Qiqi, W side of Gaoligong Shan, 1660 m, 31 Oct 2004, *GLGS 21236* (CAS); same data, *GLGS 21290* (CAS); same data, *GLGS 21307* (CAS); above Panjiasheng between Shigong Qiao and Xixiaofang, trail from Bapo to Gongshan via Qiqi, W side of Gaoligong Shan, 2340 m, 2 Nov 2004, *GLGS 22106* (CAS); W side of the Dulongjiang Valley, ca. 1 direct km NW of Maku and ca. 3.6 direct km NE of Myanmar border, 2070 m, 17 Aug 2006, *GLGS 32375* (CAS); Meiliwang, 2000 m, 5 Jun 2006, *Lu 67A* (CAS); same data, *Lu 67B* (CAS); S of Tsunwangtu, 1600 m, 21 Nov 1938, *Yü 21060* (A, E).

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We thank the curators of the herbaria listed in the materials and methods section, who kindly made specimens available, and particularly J. Gregson of the British Museum for supplementary collection information concerning the type of *Gaultheria bryoides*; Jon Fong of the California Academy of Sciences for help with the collection database; D. Middleton and one anonymous reviewer for helpful comments on the manuscript; Dong Lin for some of the photographic images; and Alan Chou for the illustrations. This work was supported by U.S. National Science Foundation grants DEB-0103795 and DEB-0717711 to the first author.

LITERATURE CITED

- AIRY SHAW, H.K. 1941. XLIII—Studies in the Ericales: IV. Classification of the Asiatic species of *Gaultheria*. *Kew Bulletin* 1940:306–330.
- CHAPLIN, G. 2005. Physical geography of the Gaoligong Shan area of southwest China in relation to biodiversity. *Proceedings of the California Academy of Sciences*, ser. 4, 56:527–556.
- COPELAND, H.F. 1931. Philippine Ericaceae III. A taxonomic revision. Genus *Gaultheria* L. *Philippine Journal of Science* 47:57–63.
- FANG, R.C. 1999. New taxa of Ericaceae from China. *Taxon* 9:162–178.
- FANG, R.C., AND P.F. STEVENS. 2005. *Gaultheria*. Pages 464–475 in Z.Y. Wu and P.H. Raven, eds., *Flora of China: Myrsinaceae through Loganiaceae*, vol. 14. Science Press, Beijing, China and Missouri Botanical Garden Press, St. Louis, Missouri, USA.
- FRITSCH, P.W., AND D.K. TROCK. 2007. Lectotypification of *Gaultheria pyrolifolia* and *G. pyrolloides* (Ericaceae). *Journal of the Botanical Research Institute of Texas* 1:97–102.
- HARA, H. 1982. Ericaceae. Pages 54–60 in H. Hara, A.O. Chater, and L.H.J. Williams, eds., *An Enumeration of the Flowering Plants of Nepal*, vol. 3. Trustees of British Museum (Natural History), London, UK.
- KRESS, J.K., R.A. DEFILLIPPS, E. FARR, AND D.Y.Y. KYI. 2003. A checklist of the trees, shrubs, herbs, and climbers of Myanmar. *Contributions from the United States National Herbarium* 45:1–590.
- KRON, K.A., W.S. JUDD, P.F. STEVENS, D.M. CRAYN, A.A. ANDERBERG, P.A. GADEK, C.J. QUINN, AND J.L. LUTEYN. 2002. Phylogenetic classification of Ericaceae: Molecular and morphological evidence. *Botanical Review* 68:335–423.

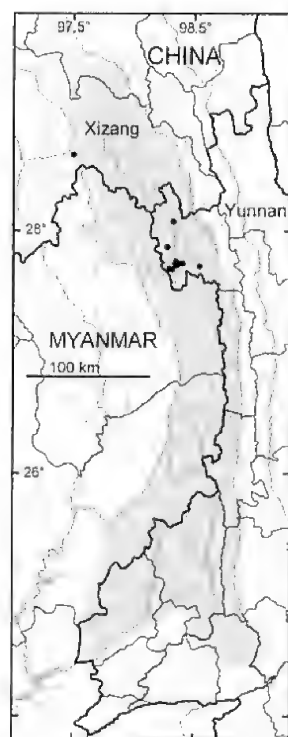


FIGURE 46. Distribution map of *Gaultheria wardii* in the GLGS region.

- LI, H., H.J. GUO, AND Z.L. DAO. 2000. *Flora of Gaoligong Mountain*. Science Press, Beijing, China. xxiii + 1344 pp.
- LIU, A.-Z., AND W.J. KRESS. 2005. The Gaoligong Mountains of Southwest China and Northeast Myanmar. Pp. 86–92 in G.A. Krupnick and W.J. Kress, eds., *Plant Conservation. A Natural History Approach*. University of Chicago Press, Chicago, Illinois, USA.
- LONG, D.G. 1988. Notes relating to the flora of Bhutan: XIII. *Notes from the Royal Botanic Garden Edinburgh* 45:327–335.
- MCNEILL, J., F.R. BARRIE, H.M. BURDET, V. DEMOULIN, D.L. HAWKSWORTH, K. MARHOLD, D.H. NICOLSON, J. PRADO, P.C. SILVA, J.E. SKOG, J.H. WIERSEMA, AND N.J. TURLAND, eds. 2006. *International Code of Botanical Nomenclature (Vienna Code)*. A.R.G. Gantner, Ruggell, Liechtenstein. xviii + 568 pp.
- MIDDLETON, D.J. 1991. Infrageneric classification of the genus *Gaultheria* L. (Ericaceae). *Botanical Journal of the Linnean Society* 106:229–258.
- POWELL, E.A., AND K.A. KRON. 2001. An analysis of the phylogenetic relationships in the wintergreen group (*Diplycosia*, *Gaultheria*, *Pernettya*, *Tepuia*; Ericaceae). *Systematic Botany* 26:808–817.
- RAE, S.J. 1991. *Gaultheria*. Pages 387–392 in A.J.C. Grierson and D.G. Long, eds., *Flora of Bhutan*, vol. 2, pt. 1. Royal Botanic Garden, Edinburgh, UK.
- REHDER, A. AND E.H. WILSON. 1913. Ericaceae. Pages 503–562 in C.S. Sargent, ed. *Plantae Wilsonianae*, vol. 1. The University Press, Cambridge, Massachusetts, USA.
- SLEUMER, H. 1957. *Florae Malesianae praecursores* XIV. The genus *Gaultheria* in Malaysia. *Reinwardtia* 4:163–188.
- SLEUMER, H. 1966. Ericaceae. Pages 469–668 in C.G.G.J. van Steenis, ed., *Flora Malesiana*, ser. 1, vol. 6, pt. 4. N.V. Dijkstra's Drukkerij V/H Boekdrukkerij Gebr. Hoitsema, Groningen, Netherlands.
- SMITH, W.W. 1919. Diagnoses specierum novarum in herbario Horti Regii Botanici Edinburgensis cognitum. CCCCI–CCCCL. *Notes from the Royal Botanic Garden Edinburgh* 11:191–232.
- STEENIS, C.G.G.J. VAN, ED. 1950. *Flora Malesiana*, ser. 1, vol. 1. Noordhoff-Kolff n.v., Djakarta, Indonesia.
- STOTZ, D.F., E.J. HARRIS, D.K. MOSKOVITS, K. HAO, S. YI, AND G.W. ADELMANN, EDS. 2003. *China: Yunnan, Southern Gaoligongshan. Rapid Biological Inventories Report no. 4*. The Field Museum, Chicago, Illinois, USA. 144 pp.
- TAKEDA, H. 1918. Notes on far eastern plants. *Botanical Magazine (Tokyo)* 32:194–203.
- XU, T.Z. 1981. Preliminary study of classification on Chinese *Gaultheria*. *Acta Botanica Yunnanica* 3:417–434.
- XU, T.Z. 1986a. *Gaultheria*. Pages 585–602 in Z.Y. Wu, ed., *Flora Yunnanica*, vol. 4. Science Press, Beijing, China.
- XU, T.Z. 1986b. *Gaultheria*. Pages 691–706 in Z.Y. Wu, ed., *Flora Xizangica*, vol. 3. Science Press, Beijing, China.
- XU, T.Z. 1991a. *Gaultheria*. Pages 45–69 in R.C. Fang, ed., *Flora Reipublicae Popularis Sinicae*, vol. 57(3). Science Press, Beijing, China.
- XU, T.Z. 1991b. *Chiogenes*. Pages 69–71 in R.C. Fang, ed., *Flora Reipublicae Popularis Sinicae*, vol. 57(3). Science Press, Beijing, China.
- ZHOU, L.H., P.W. FRITSCH, AND B. BARTHOLOMEW. 2006. The Symplocaceae of Gaoligong Shan. *Proceedings of the California Academy of Sciences*, ser. 4, 57:387–431.

Appendix 1

Abbreviations for Collectors and Expeditions that Record Ten or More *Gaultheria* Collections in the GLGS Area

| | |
|------|---|
| BE | Bijiang Expedition |
| F | Forrest, George |
| Feng | Feng, Kuo-mei |
| GLGS | (includes 17 collecting activities with the same number series) Dulong Jiang Investigation Team, 1990–1991; Gaoligong Shan Expedition, 1996–1997; Li Heng, Bruce Bartholomew, & Dao Zhiling, 1998; Li Heng, Bruce Bartholomew, Philip Thomas, Peter Fritsch, Dao Zhiling, Wang Zhonglan, & Li Rong, 2000; Li Heng, Dao Zhiling, & Yin Liwei, 2000; Li Heng, Dao Zhiling, Long Chunlin, Li Rong, & Liu Yitao, 2001; Li Heng, Dao Zhiling, Yin Liwei, & Li Rong, 2001; Li Heng, Ji Yunheng, & Li Rong, 2002; Li Heng, Li Rong, & Dao Zhiling, 2002; Gaoligong Shan Biodiversity Survey, 2001–2006 with the following participants: Li Heng, Dao Zhiling, Li Rong, Ji Yunheng, Liu Bengxi, Peter Fritsch, Bruce Bartholomew, Mark Watson, & David Knott, 2002; Li Heng, Dao Zhiling, Li Rong, Jiang Zhutan, Bruce Bartholomew, & Lihua Zhou, 2003; Li Heng, Dao Zhiling, Li Rong, Jiang Zhutan, Ji Yunheng, Peter Fritsch, Lihua Zhou, & Kate Armstrong, 2004; Li Heng, Dao Zhiling, Li Rong, Jiang Zhutan, Zhang Yuemei, Bruce Bartholomew, Lihua Zhou, David Long, Crinan Alexander, Martyn Dickson, & Katherine Bach, 2004; Li Heng, Dao Zhiling, Ji Yunheng, Gao Fu, Liu Benxi, Peter Fritsch, Lihua Zhou, & Martyn Dickson, 2005; Li Heng, Dao Zhiling, Ji Yunheng, Liu Benxi, Tang Anjun, Bruce Bartholomew, Lihua Zhou, Jin-Hyub Paik, & Simon Crutchley, 2005; Li Heng, Dao Zhiling, Ji Yunheng, Bruce Bartholomew, Lihua Zhou, Neil McCheyne, & Jin Xiaohua, 2006; Li Heng, Dao Zhiling, Ji Yunheng, Hu Guangwan, Peter Fritsch, Jin Xiaohua, Jin-Hyub Paik, Simon Crutchley, & Catherine Bush, 2006. |
| KW | Kingdon Ward, Frank |
| Lu | Lu, Lu & Lu Ren-fu |
| NE | Nujiang Expedition |
| NT | Nanshui Team |
| QX | Qinghai-Xizang Expedition |
| Rock | Rock, Joseph F. Charles |
| Tsai | Tsai, Hse-tao |
| Wang | Wang, Chi-wu |
| Wu | Wu, Su-kong |
| Yü | Yü, Te-tsun |

Appendix 2**List of Species**

1. *Gaultheria bryoides* P.W. Fritsch & L.H. Zhou
2. *Gaultheria cardiosepala* Handel-Mazzetti
3. *Gaultheria cuneata* (Rehder & E.H. Wilson) Bean
4. *Gaultheria discolor* F. Muell.
5. *Gaultheria dolichopoda* Airy Shaw
6. *Gaultheria dumicola* W. W. Smith
7. *Gaultheria eciliata* (S.J. Rae & D.G. Long) P.W. Fritsch & L.H. Zhou
8. *Gaultheria fragrantissima* Wallich
9. *Gaultheria griffithiana* Wight
10. *Gaultheria hookeri* C.B. Clarke
11. *Gaultheria hypochlora* Airy Shaw
- 12a. *Gaultheria leucocarpa* var. *pingbienensis* C.Y. Wu & T.Z. Xu
- 12b. *Gaultheria leucocarpa* var. *hirsuta* (D. Fang & N.K. Liang) T.Z. Xu
13. *Gaultheria nivea* (J. Anthony) Airy Shaw
14. *Gaultheria notabilis* J. Anthony
15. *Gaultheria nummularioides* D. Don
16. *Gaultheria praticola* C.Y. Wu ex T.Z. Xu
17. *Gaultheria pseudonotabilis* H. Li ex R.C. Fang
18. *Gaultheria pyrolifolia* J.D. Hooker ex C.B. Clarke
19. *Gaultheria semi-infera* (C.B. Clarke) Airy Shaw
20. *Gaultheria sinensis* J. Anthony
21. *Gaultheria suborbicularis* W.W. Smith
22. *Gaultheria thymifolia* Stapf ex Airy Shaw
23. *Gaultheria trichophylla* Royle
24. *Gaultheria wardii* C. Marquand & Airy Shaw

Appendix 3**Index to Exsiccatae**

All specimens examined by the authors are listed alphabetically by collector, followed by collection numbers. Numbers in parentheses correspond to those in the numerical list of species. Collections with more than one species listed are mixed collections.

J.D. Anderson (12a).

BE 9 (19); 86 (6); 611 (16); 794 (19); 1006 (19); 1351 (2); 1351A (20); 1486 (6); 1498 (19); 1607 (19); 1608 (19); 1742 (10).

J. Chen 657 (8); 679 (12b); 720 (6); 723 (19); 1029 (8).

M. Chen 3556 (19).

S.Z. Chen 7102 (10).

Dao et al. 9435 (10).

F 5003 (2); 5066 (10); 7466 (8); 7659 (8); 7702 (19); 7730 (6); 7965 (12b); 8573 (6); 8757 (19); 8780 (15); 8786 (19); 8931 (2); 8949 (9); 9003 (10); 9061 (12b); 9120 (9); 9298 (12b); 9331 (19); 9335 (8); 9364 (15); 9389 (8); 9568 (6); 9591 (8); 9694 (8); 9792 (8); 11778 (10); 12021 (2); 12344 (8); 14966 (10); 14997 (10); 15742 (10); 15785 (6); 15809 (10); 15986 (19); 17579 (15); 17774 (6); 17984 (19); 18021 (10); 18098 (8); 18134 (9); 18141 (16); 18360 (10); 18542 (19); 18805 (19); 18832 (6); 18972 (9); 19269 (13); 19286 (20); 19865 (18); 19867 (15); 19888 (21); 20040 (20); 20267 (21); 20868 (15); 20871 (15); 20872 (21); 22844 (21); 25172 (15); 26075 (6); 26181 (19); 26722 (14); 26867 (22); 27777 (19); 29050 (19); 29457 (8); 29648 (19); 29649 (9); 29668 (2); 29704 (10); 29803 (8); 29840 (9); 29984 (19); 30371 (19); 30879 (2).

R.J. Farrer 895 (2); 990 (10); 1068 (19); 1191 (11); 1622 (20); 1676 (11); 1677 (22); 1679 (10); 1737 (11).
Feng 7543 (19); 7666 (10); 7675 (9, 23); 7675 (20); 7804 (11); 8169 (8); 8313 (11); 8417 (22); 8419 (10);
8600 (19); 8643 (9); 24318 (6); 24557 (9); 24684 (10); 24691 (15); 24715 (8); 24723 (19); 24731 (17).
Fragrance Resources Expedition 85-229 (8).
GLGS 61 (6); 201 (8); 780 (8); 826 (24); 835 (8); 885 (8); 915 (17); 977 (15); 996 (8); 1071 (8); 1087 (24);
1101 (6); 1108 (8); 1368 (24); 1394 (8); 1441 (24); 1579 (15); 1598 (19); 1608 (24); 1653 (8); 1704 (15);
1748 (8); 1830 (8); 1881 (6); 1930 (8); 1941 (24); 1996 (8); 2050 (8); 2175 (8); 2234 (8); 3144 (8); 3149
(17); 3210 (24); 3267 (6); 3268 (6); 3275 (8); 3281 (19); 3300 (6); 3406 (17); 3710 (6); 3948 (15); 4076
(8); 4114 (8); 4115 (17); 4152 (17); 4176 (8); 4202 (8); 4203 (8); 4231 (17); 4232 (8); 4255 (24); 4446
(17); 4550 (6); 4562 (6); 4634 (17); 4669 (17); 4713 (8); 4810 (8); 5158 (8); 5256 (8); 5338 (8); 5366 (8);
5395 (17); 5435 (8); 5471 (8); 5522 (8); 5677 (8); 5773 (8); 5912 (9); 5984 (8); 6049 (15); 6056 (9); 6058
(8); 6059 (10); 6173 (19); 6175 (6); 6273 (8); 6437 (9); 6738 (17); 6841 (8); 6846 (6); 6907 (6); 6926 (10);
6954 (15); 6981 (24); 7008 (8); 7013 (17); 7040 (15); 7220 (19); 7248 (19); 7261 (9); 7262 (19); 7285 (9);
7569 (8); 7677 (15); 7709 (19); 7732 (19); 7733 (9); 7735 (15); 7752 (10); 7758 (11); 7794 (15); 7811
(10); 7885 (9); 7887 (19); 7905 (9); 8013 (6); 8018 (9); 8040 (19); 8063 (6); 8120 (19); 8132 (10); 8133
(10); 8210 (19); 8215 (6); 8252 (19); 8285 (10); 8816 (8); 9142 (8); 9517 (15); 9576 (10); 9960 (10);
10048 (19); 10222 (19); 10412 (19); 10427 (9); 10941 (15); 10983 (12b); 11078 (6); 11123 (6); 11340
(19); 11348 (19); 11550 (9); 11752 (9); 11768 (8); 11770 (8); 11839 (19); 11889 (10); 11939 (19); 11982
(19); 12048 (8); 12061 (8); 12213 (8); 12221 (17); 12245 (19); 12246 (8); 12270 (8); 12293 (9); 12295
(24); 12494 (15); 12550 (15); 12551 (20); 12582 (9); 12700 (10); 12770 (10); 13197 (6); 13302 (8); 13428
(6); 13445 (9); 13596 (15); 13601 (6); 13735 (9); 13771 (15); 14144 (8); 14271 (19); 14361 (8); 14454
(9); 14487 (8); 14518 (8); 14590 (8); 14704 (8); 14751 (8); 14793 (9); 14794 (20); 14829 (10); 14937 (17);
15033 (20); 15232 (8); 15630 (8); 15954 (10); 15970 (19); 15971 (9); 16503 (10); 16548 (8); 16565 (17);
16708 (15); 16711 (10); 16725 (10); 16786 (10); 16809 (10); 16817 (11); 16818 (15); 16874 (7); 16876
(11); 16918 (11); 16928 (16); 16935 (10); 16950 (11); 16952 (7); 16953 (15); 17007 (11, 20); 17032 (11);
17105 (9); 17128 (15); 17129 (19); 17711 (6); 17831 (6); 18071 (8); 18202 (12b); 18574 (9); 18687 (6);
18688 (8); 18737 (9); 18788 (9); 18831 (6); 18842 (9); 18883 (6); 19536 (8); 19546 (8); 19824 (8); 20029
(9); 20086 (10); 20137 (9); 20140 (20); 20182 (15); 20245 (6); 20247 (9); 20283 (9); 20393 (10); 20395
(10); 20396 (10); 20401 (9); 20752 (8); 20831 (9); 20833-A (6); 20834 (19); 20969 (20); 20970 (11);
20975 (20); 21123 (19); 21236 (24); 21290 (24); 21307 (24); 21311 (8); 21406 (19); 21446 (8); 21560 (8);
21618 (8); 21930 (8); 21970 (19); 22005 (5); 22006 (15); 22027 (6); 22083 (15); 22106 (24); 22337 (19);
22343 (19); 22373 (10); 22389 (10); 22409 (2); 22520 (15); 22682 (9); 22690 (10); 22883 (10); 22908
(10); 22922 (2); 22945 (9); 22994 (9); 23014 (10); 23018 (2); 23029 (10); 23073 (15); 23099 (15); 23109
(9); 23145 (9); 23303 (19); 23306 (10); 23318 (10); 23757 (6); 23946 (10); 24198 (9); 24242 (9); 24247
(10); 24382 (6); 24437 (9); 24458 (10); 24485 (10); 24499 (9); 24505 (9); 24520 (10); 24539 (10); 24542
(10); 24565 (8); 24613 (8); 25065 (8); 25120 (9); 25199 (9); 25318 (9); 25674 (19); 25749 (2); 26076 (9);
26086 (9); 26349 (6); 26352 (19); 26533 (15); 26546 (19); 26706 (15); 26754 (20); 26900 (9); 26907 (19);
26921 (20); 27029 (11); 27161 (20); 27221 (11); 27273 (9); 27387 (6); 27585 (8); 27742 (8); 28202 (8);
28289 (10); 28320 (19); 28326 (9); 28422 (19); 28428 (19); 28441 (11); 28462 (9); 28473 (15); 28482
(19); 28501 (20); 28628 (11); 28629 (11); 28682 (10); 28741 (19); 28745 (19); 28780 (19); 28827 (19);
28828 (19); 28845 (6); 28854 (19); 28857 (9); 28865 (19); 29152 (10); 29210 (9); 29222 (10); 29239 (19);
29243 (10); 29289 (19); 29291 (9); 29462 (6); 29464 (8); 29465 (8); 29505 (15); 29522 (15); 29757 (8);
29885 (15); 29886 (8); 29889 (8); 29895 (8); 29974 (9); 30053 (9); 30125 (10); 30509 (19); 30511 (9);
30532 (19); 30558 (9); 30568 (9); 30596 (9); 30658 (9); 30663 (19); 30676 (6); 30685 (9); 30787 (19);
30853 (8); 30855 (8); 31006 (6); 31011 (9); 31118 (8); 31158 (11); 31446 (22); 31581 (13); 31589 (20);
31667 (7); 31683 (11); 31751 (8); 32019 (7); 32036 (11); 32041 (7); 32053 (11); 32056 (16); 32060 (11);
32074 (11); 32078 (7); 32080 (11); 32102 (7); 32127 (11); 32150 (20); 32150A (11); 32170 (20); 32235
(11); 32375 (24); 32379 (15); 32380 (19); 32433 (19); 32478 (6); 32505 (8); 32542 (4); 32576 (19); 32754
(15); 32809 (20); 33104 (8); 33113 (17); 33398 (17); 33545 (8); 33681 (9); 33689 (15); 33693 (8); 33699
(9); 33742 (8); 33750 (8); 33810 (15); 33822 (10); 33876 (15); 33929 (11); 33932 (10); 34040 (10); 34046
(10); 34048 (10); 34057 (15); 34106 (11); 34131 (19); 34188 (15); 34210 (19); 34352 (15); 34356 (19);
34411 (19).

J.W. & C.J. Gregory B. G.-3 (10).

H.F. v. Handel-Mazzetti 8953 (10); 9027 (19); 9382 (11); 9441 (22); 9449 (15); 9589 (15); 9763 (15).

Z.G. He & B.Y. Zhang 622 (9).

KW 188 (12b); 381 (8); 850 (21); 1590 (9); 1613 (19); 1617 (10); 1627 (10); 1691 (2); 3062 (11); 3201 (9); 3486 (6); 5429 (15); 6845 (11); 6849 (22); 6944 (23); 9243 (8); 9305 (8); 9408 (9); 9488 (9); 9556 (10); 9570 (10); 9573 (9, 10); 9639 (21, 23); 9648 (18); 9701 (23); 10960 (15); 12971 (15); 13005 (5); 13172 (15); 13172a (15); 13216a (1); 13478 (15); 13489 (6).

Kunming Station of Chinese Acad. Sci. 12977 (19).

R.Q. Li 1 (15); 3 (15).

S.H. Li 80-599 (6); 80-607 (19).

Q. Lin 770596 (9); 770689 (19); 790673 (9); 790963 (9); 790977 (19); 790982 (19); 791043 (21); 792037 (20); 791942 (15).

Lu 21 (20); 22 (2); 28 (15); 40 (11); 56 (16); 58A (5); 6-39 (9); 66 (6); 67A (24); 67B (24); 70 (19); 101 (6); 102 (6); 103 (19); 108 (17); 109 (19).

F. Ludlow & G. Sherriiff 1721 (10); 1782 (18); 6356 (15); 15143 (18); 15158 (20).

F. Ludlow et al. 13323 (18); 13972 (18).

NT 8523 (10); 8528 (9); 8807 (9); 8825 (19); 9075 (8); 9095 (9); 9255 (10); 10398 (9); 10414 (10); 10416 (10).

NE 908 (6); 1853 (2); 7876 (18); 79-3 (8); 79-36 (8); 79-46 (8); 79-76 (10); 79-86 (20); 79-134 (21); 79-255 (9); 79-295 (10); 79-388 (19); 79-557 (10); 79-558 (20); 79-618 (10); 79-636 (19); 79-665 (10); 79-714 (22); 79-928 (19); 79-1076 (10); 79-1077 (10); 79-1099 (10); 79-1102 (16); 79-1169 (8); 79-1242 (8); 79-1249 (8); 79-1383 (10); 79-1666 (19); 79-1891 (19).

NW Yunnan expedition 8232 (6); 10343 (6).

QX 6998 (20); 7206 (19); 7247 (9); 7248 (10); 73-187 (24); 73-191 (8); 73-542 (15); 7407 (9); 7547 (3); 7557 (9); 7580 (11); 7769 (10); 7944 (8); 7994 (8); 8028 (8); 8161 (19); 8254 (15); 8345 (11); 8726 (20); 8751 (15); 8827 (8); 8858 (24); 8939 (6); 9399 (8); 9664 (6); 9738 (19); 9751 (6); 9776 (15); 9998 (19); 10015 (19); 10056 (15); 10107 (20); 10128 (21); 10228 (7).

Rock 7210 (19); 7238 (19); 7293 (6); 7293a (6); 7384 (15); 7692 (19); 7887 (8); 7902 (8); 10252 (22); 11230 (19); 22335 (10); 22338 (10); 22340 (18); 22407 (11); 22435 (10); 22436 (10, 18); 22653 (3).

C.K. Schneider 2561 (6); 2606 (19).

X.C. Shi 408 (9); 682 (10).

Sukoe 10080 (2).

G.D. Tao 12813 (6).

Tsai 54104 (9); 54254 (19); 54404 (6); 54448 (9); 54472 (19); 54473 (9); 54572 (19); 54726 (6); 54770 (6); 54817 (6); 54938 (19); 54947 (8); 55732 (8); 56477 (8); 56532 (19); 56533 (6); 56578 (8); 56641 (6); 57788 (19); 58139 (10); 58172 (20); 58197 (2); 58322 (9); 58323 (19); 58420 (19); 58538 (6); 58671 (6); 59026 (19); 59061 (6); 59162 (6).

Wang 66678 (20, 21); 66695 (3); 66779 (10); 66785 (10); 67099 (20); 67144 (15); 67181 (15); 67194 (22); 67196 (11); 67423 (19); 67423-A (19); 67506 (19); 67511 (15); 90126 (6).

Wu 6608 (12b); 6647 (9); 6886 (2); 6888 (10); 6924 (19); 6955 (10); 7316 (6); 7333 (20); 8356 (6); 8416 (2).

L.S. Xie 853 (9); 886 (2).

J.S. Yang & X.N. Wang 63-1351 (22).

Yin 60-1044 (6); 60-1241 (15).

Yü 7998 (3); 8917 (3); 10192 (3); 19140 (8); 19321 (10); 19492 (8); 19501 (15); 19503 (19); 19641 (19); 19684 (21); 19732 (23); 19877 (7); 19879 (18); 20049 (11); 20058 (11); 20206 (19); 20232 (15); 20262 (11); 20324 (2); 20336 (7); 20574 (15); 20613 (22); 20672 (10); 20683 (20); 20709 (11); 20737 (21); 20821 (22); 20822 (15); 20830 (15); 20831 (19); 20873 (6); 20999 (6); 21060 (24); 22085 (15); 22964 (10); 22965 (15); 23115 (15).

Y.M. Zhang 307 (19).

J.Z. Zhao 7 (6); 8 (12b).

One Hundred and Fifty Years of Botany at the California Academy of Sciences (1853–2003)

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FOREWORD

History does not write itself, which is why my name appears on this publication. Although assembling it has taken me from my studies of Acanthaceae and work on a nearly completed account of the flora of San Francisco County, my work on this project has truly been a labor of love. Who would not enjoy writing about such fascinating characters, their tragedies and triumphs, and the influence they had on their department, institution, and discipline?

This account is “a” history of botany at the California Academy of Sciences rather than “the” history of botany there. It focuses on the most famous curators in the Department of Botany: Kellogg, Curran/Brandege, Eastwood, and Howell. I harbor enormous respect for each of them and what they accomplished under circumstances far less ideal than those enjoyed by curators at the Academy today. Their achievements resulted primarily from who they were as individuals rather than from support afforded by their employer. In time, Breedlove’s name may join them based largely on his important collections from Chiapas, his collaborative ethnobotanical studies, and his influence on the evolution of the Academy’s Department of Botany into a major center for tropical systematics. The current curators owe an enormous debt to our predecessors who established botanical science at the Academy and built a solid foundation for its future.

Much of this account grew out of my presidential address to the American Society of Plant Taxonomists in 2001. Many members of that audience indicated that the stories involving Kellogg, Curran/Brandege, Eastwood, and Howell should be published to inspire future generations of plant systematists. While only a few of “the tales” from that talk are related in this account, all of them can be found among the literature cited herein.

At the Academy, I have benefited from the invitation of Alan Leviton, Editor of Scientific Publications, to write an account of the Department of Botany; archivists and librarians Michelle Wellck, Karen Elsbernd, Larry Currie, and Anne Malley of the Academy’s Library and Special Collections who provided access to materials in their care and helped me locate other references; Department of Botany associate Catherine Best who wrote up an account of the recent history of the California Botanical Club for my use; and the staff of the Department of Botany (especially collections manager Bruce Bartholomew, secretary Janet Jones, and senior curator Frank Almeda) who provided materials or insights that improved the text. The following individuals and organizations provided assistance for which I am most grateful: Bancroft Library of the University of California, Richard Beidleman, Meredith Blackwell, California Historical Society, Dennis Desjardin, Barbara Erter, Wilma Follett, Deborah Lewis, DeAda Mally, LuEsther T. Mertz Library of the New York Botanical Garden, Ron Petersen, Donald H. Pfister, Thomas Ranker, Peter Raven, Paul Silva, Stephen Sinon, Kim Steiner, Barbara Thiers, Susan Thomas, Sutro Library, University and Jepson

herbaria of the University of California at Berkeley, and Rebecca Wenk. I am especially grateful to Richard Beidleman, Rogers McVaugh, Peter Raven, and Alan Whittemore for reading early drafts of the manuscript and making numerous helpful comments, as well as Hallie Brignall who read intermediate versions; and to Andrew Doran for locating, scanning, and granting permission to reproduce several items from the archives of the University and Jepson herbaria, University of California, Berkeley. I made considerable use of the Department of Botany's "biography files," an informal archival resource housed in the Department that contains about 10 linear feet of archival boxes with newspaper clippings, obituaries, letters, photos, announcements, newsletter articles, etc. pertaining to botanists and others, most of whom have or had an affiliation with the Academy or other institutions/organizations in California. These files were begun either by Eastwood or Howell, and were meticulously augmented by Howell during his employment and retirement. Finally, I wish to thank the California Academy of Sciences for making possible the remarkable story of botany at the institution and for supporting my efforts to bring "a" version of that story into print.

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INTRODUCTION

The discovery of gold in the foothills of California's Sierra Nevada in 1848 was to have a major impact on the discipline of systematic botany. Before the Gold Rush of 1849, Yerba Buena had been a sleepy and isolated port village of some 459 inhabitants. With the influx of miners and those feeding and clothing them, and with California's admission to the Union in 1850, the population of the town, which had been renamed San Francisco in 1847, grew enormously. By 1853 the wildest days of the Gold Rush had past, and the growing town was attaining many of the trappings associated with contemporary cities—such as the formation of an organization devoted to the study

of natural history. On 4 April 1853, just five years after gold had been discovered at Sutter's Mill, seven men met in San Francisco to form the California Academy of Natural Sciences.

Tantalizing fragments of California's botanical bounty had been gleaned from various regions along its Pacific coast by early explorers and expeditions such as those of La Pérouse in 1786, Malaspina in 1791, von Krusenstern in 1806, and Kotzebue in 1816 (see Alden and Ifft [1943], Ewan [1955], and Thomas [1969] for details of these and other early expeditions to California). Yet, by the middle of the nineteenth century, most of the state remained *terra incognita* to the scientific community and the richness of its biological diversity was only suspected. Indeed, travel to California was primarily by ship (either around Cape Horn or to Panama, overland across the isthmus, and thence by another ship to the west coast of North America) and was both time-consuming and dangerous. Its cities were isolated from the scientific centers of Europe and the eastern United States.¹ Many of its inland mountains and valleys were part of the American frontier and those seeking to inhabit its lands tended to be hardy, self-reliant, and naturally courageous individuals. Institution-based science conducted by resident scientists was desperately needed in such a large and biologically rich area, but the obstacles to its early establishment and success would prove to be nearly insurmountable. With a good deal of luck and even more dedication and hard work from its early members, the California Academy of Sciences was able to meet its challenges, persevere through some desperate times, and remain a center for scientific activities on the Pacific Coast of North America for 150 years. The study of plants at the Academy played a major role in the institution's colorful history and scientific accomplishments.

Because there is already a considerable body of literature on the history of botany and botanists at the California Academy of Sciences, this account does not attempt to repeat all that has been published previously. Rather, it focuses on some of the departmental highlights and prominent personnel, provides access to much of the extant literature relating to botany at the Academy, and offers some information not readily available from other sources. Although this history of botany at the Academy concentrates on the Department of Botany and its curators, it also includes information about those involved in botanical activities at the institution, whether or not they were on the Department's staff. Our knowledge of botanical activities at the Academy during its first fifty years has been greatly enhanced with the publication by Leviton and Aldrich (1997) of Theodore H. Hittell's historical sketch of the institution from 1853 until 1906, to which they made substantive additions.²

The historical account below is divided into five chapters, each representing a distinctive period of time for botany at the Academy, and most focusing on a single prominent curator. A sixth chapter provides some insights and perspectives on botanical science and its practitioners at the Academy during the past 150 years. Endnotes and appendices offer additional relevant information and place some of the events, activities, and people into a broader context.

I. BEGINNINGS AND EARLY HISTORY (1853–1883)

The study of plants and maintenance of an herbarium date from the earliest days of the California Academy of Sciences.³ The promotion of natural science in the new state of California⁴ was the stated goal of the Academy's founders from their first meeting in 1853. As central to its mission, the Academy sought to survey the natural resources of California and to make a "collection of a cabinet of her rare and rich productions" (Hittell 1997:13). Thus, the scientific study of plants in San Francisco was inevitable. Furthermore, three of the seven founders of the Academy were doctors of medicine, and, at that time, botany was an essential component of medical science and education. At the meeting of 18 July 1853, Academy president Andrew Randall (Fig. 1A) offered

“a reward for certain essays on trees” (Miller 1942). An essay contest was held and at the meeting of 2 January 1854, a prize of \$50 was awarded for “the most complete and practical essay on Californian and exotic trees, shrubs, grasses, and plants; their adaptation to the sands and soils of the sea-coast and the shores of our bays and rivers—for breaking the violence of the coast winds, arresting and preventing sand drifts, and guarding against encroachment and damage by waves and floods; with instructions” (Miller 1942). On 24 July 1856, former president Randall was shot dead by a gambler named Joseph Hetherington. Five days later, Hetherington was lynched by the city’s Committee of Vigilance.⁵ On the day following Randall’s funeral and the day before his murderer was hanged, the Academy held its regular weekly meeting⁶ at which “Mr. A.F. Beardslee deposited for the Library, Michaux and Nuttall’s *North American Sylva*; also a pamphlet containing descriptions of new coniferous trees of California” (Miller 1942). The calm pursuit of botanical activities at the young Academy in this “wild west” atmosphere would foreshadow the perseverance of botanical science at the institution under even graver circumstances to come.

Albert Kellogg (1813–1887; Fig. 2), a physician and pharmacist with a keen interest in botany, was one of the seven founders of the Academy who attended its organizational meeting in 1853. Kellogg was born in New Hartford, Connecticut and trained in medicine at Charleston, South Carolina and at Transylvania College in Kentucky (Ewan 1953). It was during his travels in the southern and western United States for the benefit of his health that he became interested in botany (Hittell 1997).⁷ Kellogg arrived in California in 1849 and eventually settled in San Francisco where he established a pharmaceutical business and practiced some medicine (Ewan 1953). Apparently, he was not very successful at either venture; Hittell (1997:35) noted that, “Dr. Kellogg, who kept a drug-store, was almost too much engrossed with hunting and working over new plants to patiently wait upon customers,” while Greene (1887) indicated that he was never known to request payment for his services.

Neglect for his profession was balanced by enthusiasm for plants and the new Academy of amateur scholars. In fact, Kellogg was devoted to the organization from its inception. He served it in various administrative roles (e.g., vice-president, librarian, curator, and director of the museum),⁸ was appointed to numerous committees, and was a frequent and vocal participant at the meetings (Hittell 1997). As the Academy’s first curator of botany, he earnestly and optimistically believed in the success and importance of the institution and he stimulated members and visitors to communicate specimens to it for identification and study (Ewan 1953). Although he had collected plants along the west coast of South America during his voyage to San Francisco,⁹ one of his first major collecting expeditions came in 1867 when he accompanied George Davidson of the United States Coast Survey and W.G.W. Harford to Alaska (Ewan 1953). There he collected “nearly five hundred species of plants” in triplicate (Davidson 1889:v). Sets of those collections went to the Smithsonian Institution (US), the Academy of Natural Sciences (PH), and the California Academy of Sciences (CAS). His subsequent collections from various parts of the Pacific Coast of North America (primarily California; Fig. 3A–B) were often numbered, but a new number series was apparently initiated each year (Ewan 1953).

Kellogg’s innumerable papers on “Western” (primarily Californian) plant life were read before the members of the Academy and were usually accompanied by specimens and/or his drawings of the plants in question (Hittell 1997). Kellogg published his botanical discoveries in local newspapers and magazines (e.g., *The California Horticulturist and Floral Magazine*, *The Hesperian*, *Pacific Rural Press*, and *The Pacific*),¹⁰ as well as in Academy publications (e.g., *Proceedings of the California Academy of Sciences*, *Bulletin of the California Academy of Sciences*). When publication of the Academy’s *Proceedings* was suspended in 1877¹¹ Kellogg sometimes described “new” species in manuscripts that remained in the herbarium; some of these were subsequently

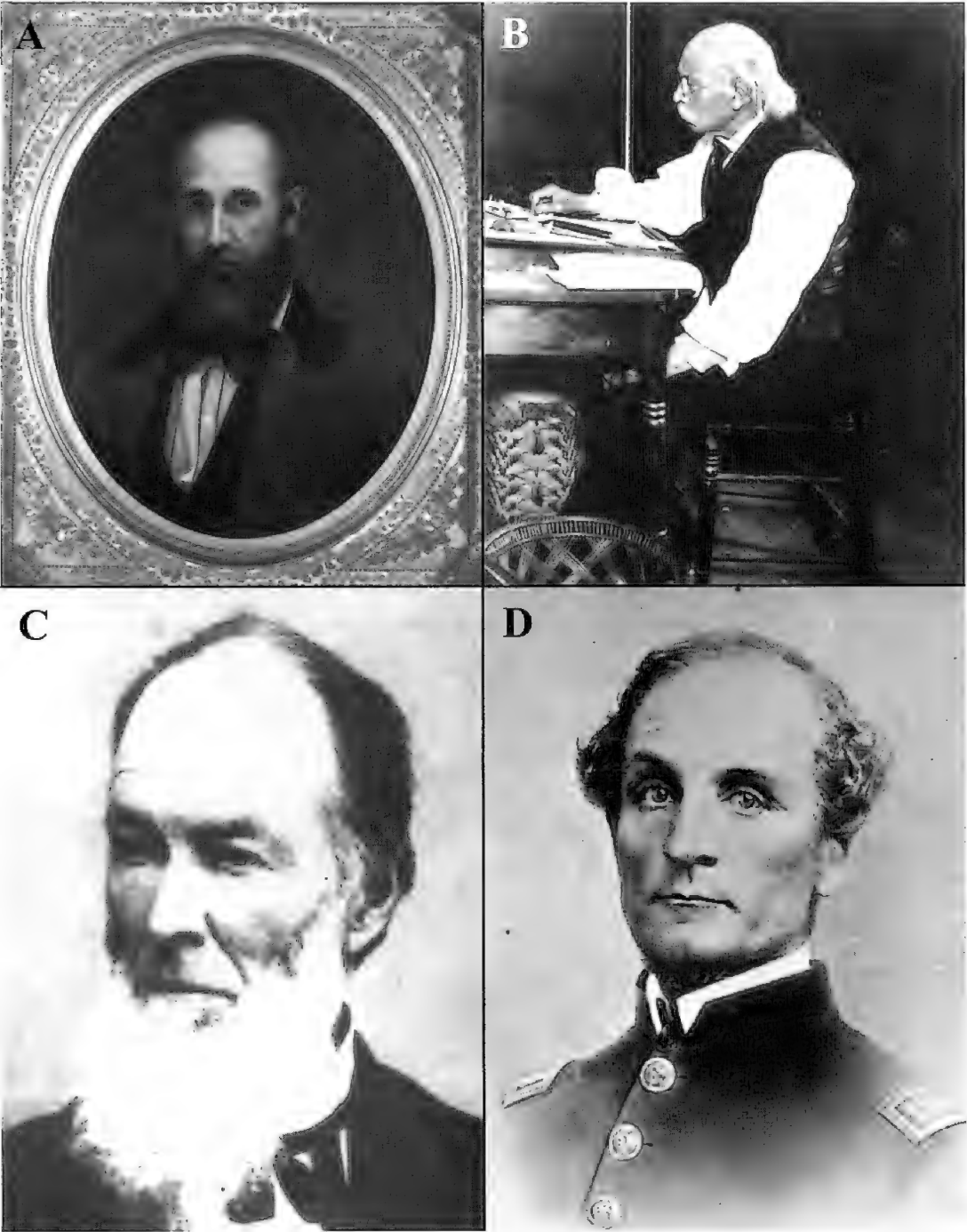


FIGURE 1. Early Academy members with botanical interests. A. Andrew Randall (from undated portrait, CAS Special Collections). B. Hans H. Behr (from Academy News Letter 37, 1943, Dept. Botany "biography files"). C. William P. Gibbons (undated photo, CAS Special Collections). D. John B. Trask (undated photo, CAS Special Collections).



FIGURE 2. Albert Kellogg at 72 years of age, Academy co-founder and first curator of botany (undated photo, UC Herbarium Archives).

described by others based on Kellogg's materials (Brandege 1893a). Kellogg's publications resulted in the initial descriptions of several well-known genera (e.g., *Marah*, *Idria*, *Bloomeria*) and 215 species (Anonymous 1943).¹²

The "Eastern" botanical establishment was not always appreciative of the attempts by the "amateurs and upstarts" (Leviton and Aldrich 1997:35) in the West (who lacked adequate library and herbarium collections) to publish their new discoveries (see Crosswhite and Crosswhite 1985). In fact, the prominent Harvard University botanist Asa Gray described Kellogg as a "good meaning soul" but "a nuisance in the science" (Dupree 1959:398).¹³ However, another prominent "Eastern" botanist, John Torrey, honored him by proposing *Kelloggia*, a genus of Rubiaceae from the



FIGURE 3. Early Academy plant collections I. A–B. Kellogg’s holotype collection of *Penstemon kingii* S Wats. var. *glaucus* Kellogg (= *P. speciosus* Dougl. ex Lindl. fide annotations by D. Keck in 1941 and J.T. Howell in 1980). C–D. Brewer’s isotype collection of *Astragalus curtipes* A. Gray, one of several putative “original” collections from the California State Geological Survey.

Sierra Nevada.

Irrespective of any faults as a botanist, Kellogg’s abilities and productivity as a botanical illustrator were considerable (Fig. 4, 5A). In 1885, curator of botany Curran indicated that Kellogg’s drawings had “only recently become accessible” to her. She published colored renditions of seven of his plates and noted that these had been “prepared for the Hesperian, and after it ceased publication, those unused were returned to him and presented to the Society [Academy] to be used in this manner” (Curran 1885:129).

Kellogg was reputed to have had a great love for all forms of plant life, but he was especially

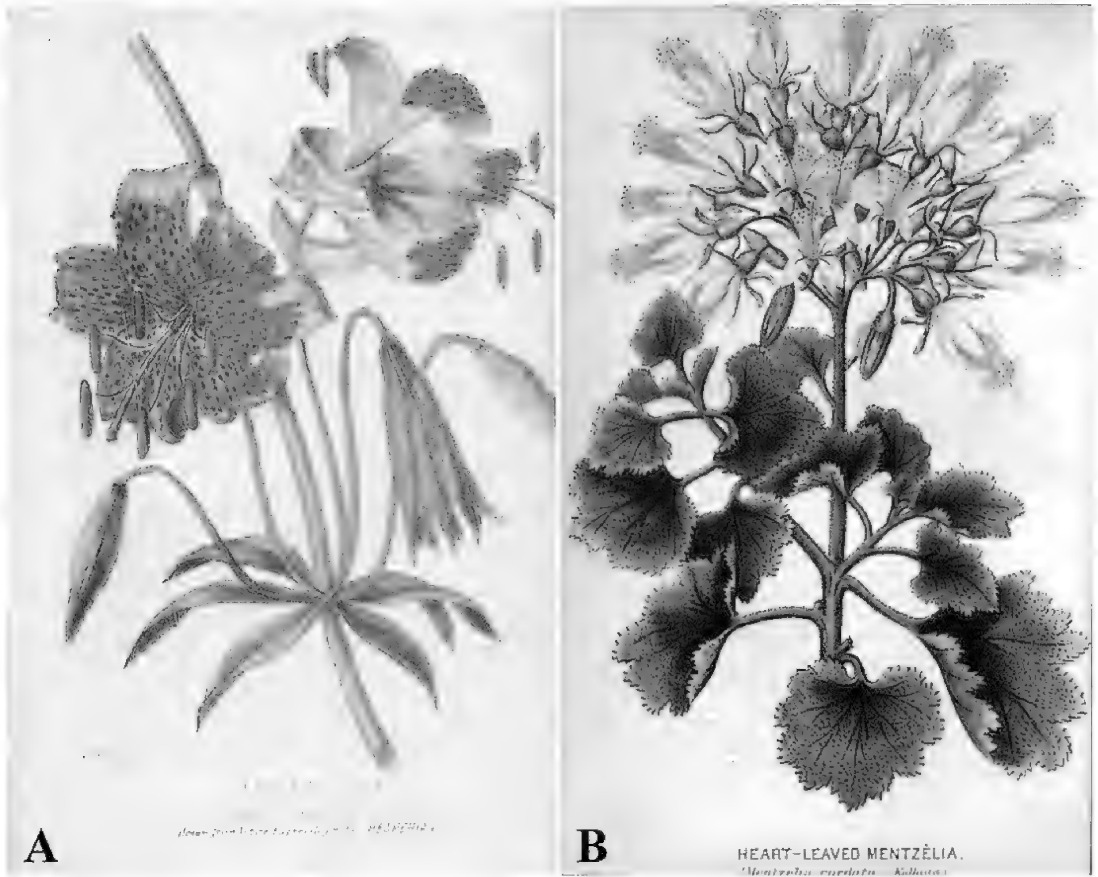


FIGURE 4. Two of Kellogg's botanical illustrations. A. *Lilium pardalinum* Kellogg (from Proc. Calif. Acad. Nat. Sci. 2:opposite page 12. 1863). B. *Mentzelia cordata* Kellogg (= *Ecnide cordata* (Kellogg) Kellogg ex Curran; from Proc. Calif. Nat. Sci. 2:opposite page 33. 1863).

interested in trees (Greene 1887). Indeed, one of Kellogg's major publications was a detailed account of the forest trees of California (Kellogg 1882). Greene (1887:151) noted that his last decade was largely devoted to illustrating trees and shrubs, of which more than 400 drawings "including all the oaks, all the coniferous trees, the poplars, many of the willows and ceanothi, dogwoods, and many herbaceous plants" were left with friends W.P. Gibbons and W. Harford to dispose of.¹⁴ Following his death, Kellogg's drawings of oaks were published by E.L. Greene as, *Illustrations of West American Oaks* (Greene 1889).¹⁵ At least five of Kellogg's original drawings survive in the Academy's herbarium (e.g., watercolor/pencil renditions of *Ribes nevadense*, *Viola purpurea*, and *Fritillaria viridea*, and pen and ink drawings of *Mertensia stomatechoides* and *Ribes menziesii*; see Appendix IV), but the fate of the bulk of them remains unknown. Parish¹⁶ and Jepson (Anonymous 1922) indicated that most of his drawings were destroyed at the time of the earthquake and fire in 1906. Indeed, Wilson (1955) also noted that Kellogg's drawings of California trees, which had been used by Eastwood to illustrate her book (Eastwood 1905), *A Handbook of the Trees of California*, had been lost in the fire.

Article 2, Section 1 of the Academy's original constitution stated that "Scientific gentlemen may be received as resident members." At the meeting of 1 August 1853, Kellogg moved "that we



FIGURE 5. Two Liliaceae named for Academy curators of botany. A. *Bloomeria aurea* Kellogg (= *B. crocea* (Torr.) Cov.), a genus named for Hiram G. Bloomer, drawn by Kellogg (from Proc. Calif. Acad. Nat. Sci. 2:opposite page 11. 1863). B. *Clintonia andrewsiana* Torr., a species named for Timothy L. Andrews (2007 photos by R. Kriebel from Butano State Park, San Mateo Co., California).

highly approve of the aid of females in every department of natural history, and that we earnestly invite their cooperation" (Hittell 1997:21). Kellogg's motion carried¹⁷ and, as noted by Miller (1942:368), "the first scientific institution in the West became probably the first in the world to recognize and encourage the ability of women in the scientific and intellectual sphere, as it was later the first institution to appoint women curators of its scientific collections." The importance of Kellogg's gesture should not be underemphasized. Notwithstanding considerable historical and sociological implications, the ramifications of Kellogg's motion, for the Academy in general and for the Department of Botany in particular, have been profound.

Kellogg remained active in the affairs of the Academy until he, the last surviving charter member of the organization, died in 1887. Kellogg has been described as possessing a particularly genial nature, and as being much admired and loved (Ewan 1953). Bosqui (1952:55–56) reminisced that "Dr. Albert Kellogg was the shining light of the Academy from its beginning. He was a thorough naturalist in the broadest sense of the word, a devoted and enthusiastic worker, and my earliest and most pleasant recollections are of him." George Davidson (1889:v), Kellogg's friend and Academy colleague, waxed poetic of their joint field trip to Alaska in 1867: "we lived in the same con-

tracted temporary deck cabin for four or five months under many trials and inconveniences, and the sweetness of his character was as pervading and refreshing as the beauty and fragrance of the flowers he gathered." Although he has been considered as the first resident botanist in central California (Thomas 1961a), like his colleagues at the young Academy, he was not a professional botanist,¹⁸ but a lover of nature with a remarkably inquisitive mind. The esteem in which he was held by his colleagues (and in consideration of his poor financial state and services he had freely furnished to the institution) is evident by their cancellation of his unpaid dues and awarding him a life membership in 1866 (Hittell 1997:80). With his gentle and unassuming manner, Kellogg made significant botanical discoveries in his adopted state, spurred the early growth of the first scientific institution in the West, influenced many of the early naturalists who were drawn to the Academy, demonstrated an early interest in conservation, and opened a new career path to women. Further insights into Kellogg's life and work were provided by Brandegee (1893a), Greene (1887), Ewan (1955), Ertter (2000), and others cited in these publications.

During the first decades of the Academy's existence, other naturalists at the institution also had botanical interests. The Academy's first president, the unfortunate Andrew Randall who was murdered in 1856, had maintained "an extensive collection of California plants, woods of native forest trees, mosses from New Mexico and the Gila country....," which the institution purchased from his estate (Hittell 1997:49).

Another of the Academy's original seven founders, John B. Trask (1824–1879; Fig. 1D) was keenly interested in botany.¹⁹ He was born in Roxbury, Massachusetts, studied at Yale College, and was widely trained or accomplished in several scientific disciplines (e.g., medicine, chemistry, geology, paleontology, and botany). Trask arrived in California during the Gold Rush of 1849 as part of a group led by John W. Audubon, son of the famous ornithologist. At the Academy, Trask served at various times as curator of several disciplines (though apparently not including botany), recording secretary, second vice-president, and first vice-president (Hittell 1997). As the first state geologist of California his reports contain references to the soils and spontaneous vegetation of various regions of the state (Jepson 1934). He collected plants in California and was particularly interested in the economic and medicinal attributes of western North American plants (Stearns 1908; Jepson 1934). For example, at the members meeting of 2 May 1864, Hittell (1997:71) noted, "Dr. Trask stated that in a recent case he had tried the roots of *Aspidium argutrum* [sic; = *Dryopteris arguta* (Kaulf.) Maxon], recommended by Dr. Behr at a recent meeting as a remedy for tape-worm and with complete success. He had used five drachms of the grated root in two doses, four drachms being first administered and in an hour afterwards one drachm more. The proper effect was produced in four and a half hours without griping or nausea. It was stated that the plant was abundant in swamps; but that hogs were rapidly destroying it. Dr. Cooper said that the Indians of Oregon used the root as medicine. Dr. Trask turned the discussion to ferns and said that in the mines the young shoots of a species of fern has been much used as a pot-herb; that it resembles asparagus; boiled easily and was nutritious."

William P. Gibbons (1812–1897; Fig. 1C), a charter member of the Academy, was also interested in botany. Gibbons was born in Wilmington, Delaware and graduated with a medical degree in 1846 from the University of New York City in 1846. He had broad interests in natural history, and at the Academy he attended meetings and took an active interest in the institution's proceedings (e.g., serving as corresponding secretary in 1853–1855, curator of geology and mineralogy in 1855). After arriving in San Francisco in 1853, he practiced medicine and pursued botanical interests in various parts of the state. After being removed from the office of corresponding secretary in 1855, Gibbons disassociated himself from the Academy for a time, but eventually became involved with the organization again, and was once again elected to membership in 1866 (Hittell 1997). In

1863, he settled in Alameda. He was very much interested in medicinal plants and served as chairman of the committee on botany of the California State Medical Society. Jepson (1897) provided a biographical sketch of Gibbons.

Dr. Timothy L. Andrews (1819–1908; no known photo) was elected the Academy's curator of botany in January 1855. Andrews was born in Danbury, Connecticut and received an M.D. degree from Castleton (Vermont) Medical College in 1845. After stints teaching school and practicing medicine, he arrived in San Francisco in 1849. During his time in California, he served as a customs inspector, assistant editor of *The Pacific* newspaper, and school teacher (Anonymous 1906; Barnhart 1965; Starr 1926). Soon after his arrival in California, Andrews relocated to Monterey where he opened a school and collected plants. Of his time there Andrews noted, "I spent every leisure hour gathering the new and beautiful flora of this newly acquired territory. The whole surface of the country seemed carpeted with flowers. Never had I conceived such beauty. It was perfectly enchanting" (quoted in "Ames Plant Exhibit" in the *Evening Times-Republican* of Marshalltown, Iowa on 14 October 1902).

Hittell (1997) reported that Andrews attended the second meeting of the Academy on 11 April 1853 and was listed as one who would become a resident member of the Academy upon signing the constitution and paying the membership fee. Andrews also served as the Academy's recording secretary in 1854, and in July of that year he was appointed to a committee to investigate land in Alameda County that was offered to the Academy for establishment of a botanical garden (Hittell 1997).²⁰ Brewer (1880:557) noted that Andrews "made considerable collections, mostly near Monterey, beginning about this time and extending over several years. Some went to the California Academy of Sciences, some to Dr. Torrey, and Dr. Newberry had others."²¹

For unknown reasons, Andrews departed San Francisco in March 1855 and returned to the eastern United States. There is no evidence that Andrews intended to remain in San Francisco or California for an extended period and his departure was perhaps not altogether unexpected. Indeed, he appears to have arrived there somewhat by circumstance to begin with. By June of 1855, he was in Marietta, Ohio whence he wrote to John Torrey several times during the summer and fall of that year. His letters reveal that he was forwarding specimens from California to Torrey, seeking to procure literature on Californian plants, and discussing Kellogg's botanical conclusions.²² In spite of his apparent infirm health, Andrews' subsequent peregrinations (primarily in the Midwestern United States) included employment as a journalist, farmer, and physician. Although his name does not figure prominently in botanical literature, the study of botany and plant collecting were life-long interests of Andrews. His personal herbarium of several thousand specimens was given to Ames Agricultural College (now Iowa State University) in 1903.²³ There being no known image of Andrews, one of the California plants named in his honor is shown in FIGURE 5B.

At the meeting of 2 April 1855, Andrews was apparently replaced as curator of botany by the German-born physician and naturalist Hans H. Behr (1818–1904; Fig. 1B) (Hittell 1997).²⁴ Behr had departed his native country as a result of his participation in the Revolution of 1848, which sought to establish a liberal and unified Germany. Prior to coming to California in 1851, Behr's travels and explorations had taken him to Australia, the East Indies, the Philippines, South Africa, and South America. He settled in San Francisco where he took up medical practice and taught classes at the California College of Pharmacy.²⁵ In 1854 Behr joined the Academy where his training, experiences, broad scientific knowledge, as well as his personal copy of Endlicher's *Genera Plantarum*, added significantly to the institution's scientific credentials and resources (Ewan 1955; Gutzkow et al. 1905). Although he served as a curator of botany in 1855, Behr is probably best known for his entomological (specializing in Lepidoptera) work at the Academy, where he became the first curator of entomology in 1862 (Hittell 1997). His major botanical contributions were two

local floras (Behr 1884, 1888) based on his extensive collecting in central California (Thomas 1969). His *Flora of the Vicinity of San Francisco* (Behr 1888) was designed for students in his classes. In addition to describing several new plants, sometimes with Kellogg as co-author, Behr published his reminiscences of botanical "observations and experiences" from "the earlier days" of San Francisco in two articles (Behr 1891, 1896). His recollections of plants, habitats, and vegetational changes in the vicinity of San Francisco provided important details and records of that city's plant life in the nineteenth century (Howell et al. 1958). Behr's plant collections in the Academy's herbarium were mostly destroyed in 1906, but duplicates of many of them presumably survive at herbaria in Hamburg, St. Petersburg, and other cities to which they were sent (Ewan 1953). The genus *Behria* (Liliaceae) was described by E.L. Greene in his honor. Additional information on Behr's life and botanical activities was provided by Gutzkow et al. (1905), Ewan (1953), Legge (1953), and Ertter (2000).

Hiram G. Bloomer (1821–1874; Fig. 6A) was born in Marlborough, New York and educated at Newburgh College. In 1849, at age 28, he attempted to join the California Gold Rush, but became ill in Panama and subsequently returned to New York. He eventually arrived in San Francisco in 1850 and became a resident member of the Academy in October 1853. He regularly attended (and sometimes lectured before or presided at) meetings of the Academy, purchased and donated botanical books to the Academy's library,²⁶ and collected and presented many plant specimens to the herbarium. (Bloomer had collected in Panama during his first and unsuccessful attempt to travel to San Francisco.) Once settled in San Francisco and at the Academy, he collected plants in California and Nevada (Richardson 1970). He served as the Academy's recording secretary in 1854; he was elected curator of botany in 1856 and apparently served in that capacity until 1863 (Jepson 1899; Thomas 1961a; Hittell 1997).²⁷

Bloomer's only known publication (Bloomer 1868) is a brief note defending the priority of the work by his colleagues, Kellogg and Behr, on the "Big Tree" or Sierra redwood (*Sequoiadendron giganteum*).²⁸ After a decade of botanical activity at the Academy, Bloomer was able to report in 1863 that the botanical collection consisted of "6,150 specimens in fair condition" (Hittell 1997:62). He was elected director of the museum in 1868, and served in that role until his untimely death in 1874.²⁹ Perhaps his most far-reaching contribution to the Academy was introducing philanthropist James Lick to science and to the institution (see below).

Following his death, Bloomer's library and personal botanical collection were purchased by the Academy from his family for \$700 (Hittell 1997:177). Jepson (1899) noted that specimens collected by Bloomer (with his handwritten labels) were present in the herbarium, but that Bloomer's personal herbarium, which consisted of several thousand specimens, was reported as "lost" at the Academy. A handwritten catalogue of the Bloomer herbarium survived the loss of the specimens, but was presumably destroyed in the San Francisco earthquake and fire of 1906. Although there is only one extant Bloomer collection among the botanical types in the Academy's herbarium (Fig. 7C–D), duplicates of Bloomer's collections had been sent to Asa Gray at Harvard and other botanists (Ewan 1953). Bloomer's major botanical interest was the Liliaceae, and he cultivated many native species of lilies in his garden (Jepson 1899). Kellogg, who also had an interest in lilies, named the genus *Bloomeria* (Liliaceae) in honor of his friend and Academy colleague (Fig. 5A). Jepson (1899) and Richardson (1970) provided biographical sketches of Bloomer, from which much of the above information has been drawn.

William G.W. Harford (1825–1911; Fig. 6B), a native of New York, came to California in 1853, and was greatly influenced by Kellogg. He was elected as a resident member of the Academy in 1866. Although his primary biological interest was in conchology (he became curator of conchology at the Academy in 1867), he was very much interested in California's plant life. As previ-

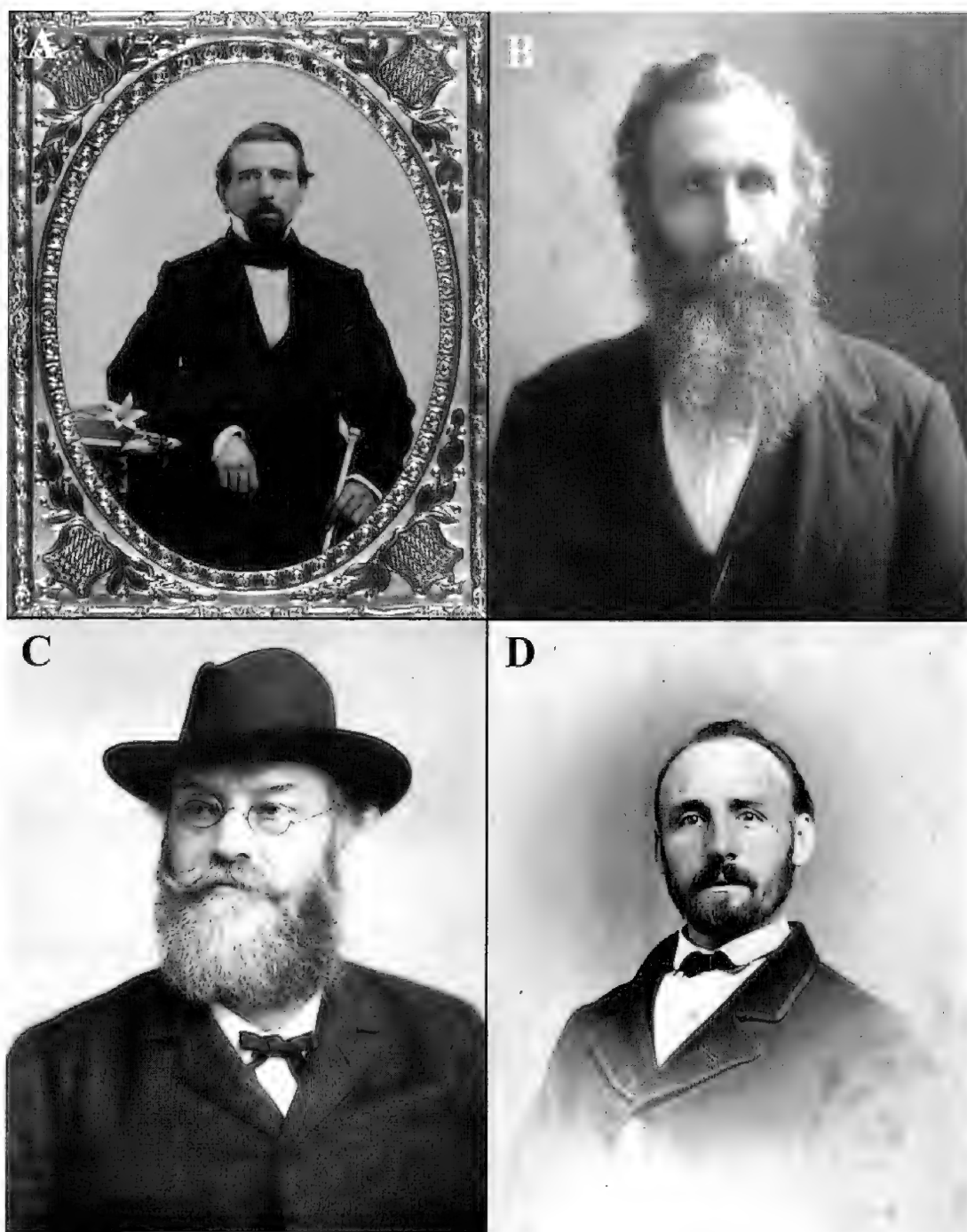


FIGURE 6. Early Academy botanists. A. Hiram G. Bloomer (undated photo, CAS Special Collections). B. William G.W. Harford (1901 photo, CAS Special Collections). C. William H. Brewer (undated photo, UC Herbarium Archives). D. Henry N. Bolander (1864 photo, UC Herbarium Archives).

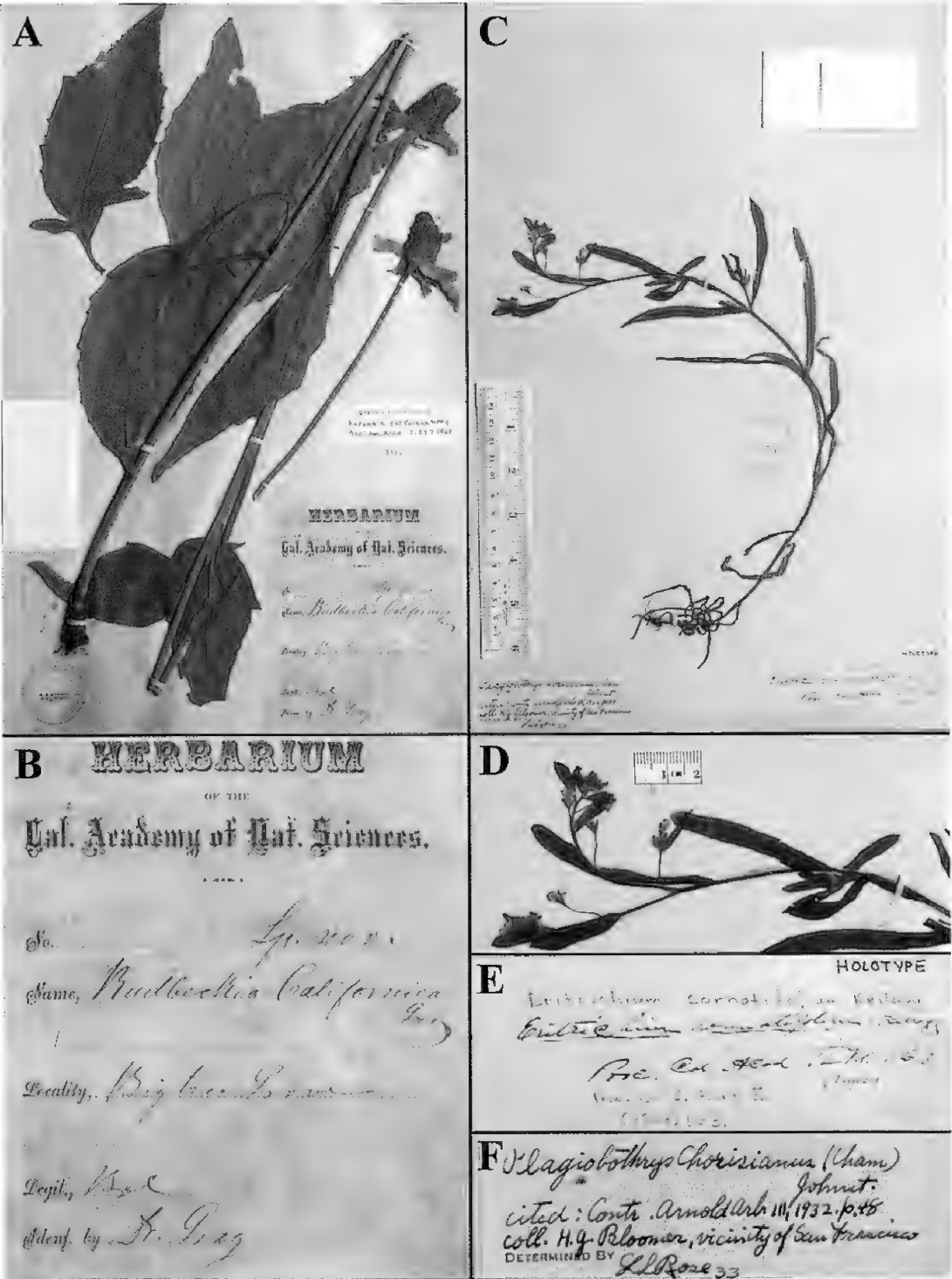


FIGURE 7. Early Academy plant collections II. A-B. Bolander's isotype collection of *Rudbeckia californica* A. Gray, one of several putative "original" collections from the California State Geological Survey. C-F. Bloomer's holotype collection of *Eritrichium comatulosum* Kellogg (= *Plagiobothrys chorisianus* (Cham.) Johnst.).

ously noted, he accompanied Kellogg and Davidson to Alaska in 1867. In 1868 and 1869, Harford and Kellogg distributed large sets of their plant collections from California and Oregon to various herbaria (e.g., those of Engelmann, Torrey, and Gray, as well as European herbaria; Jepson 1933, Ewan 1953). In temperament, Harford has been described as being even more shy and retiring than his good friend Kellogg (Ewan 1953). He served as director of the Academy's museum from 1876–1886 (Ewan 1953). Greene and Parry named *Harfordia*, a genus of Polygonaceae, in his honor.

The California State Geological Survey was established by the state's legislature in 1860 to survey the region and to prepare a report containing "a full and scientific description of its rocks, fossils, soils, and minerals, and of its botanical and zoological productions" (Whitney as quoted by Hittell 1997:65). Included among its members was William H. Brewer (1828–1910; Fig. 6C), a chemistry professor with knowledge of agriculture, who filled the role of the Survey's botanist from 1860–1864. With its headquarters in San Francisco, members of the Survey became active in, and to some extent reinvigorated, the California Academy of Sciences (Hittell 1997). Indeed, Brewer became both a resident member and recording secretary of the institution in 1862. Brewer presented several papers to the Academy, but became less involved with the institution (and was replaced as recording secretary in 1865) as more of his time was "engrossed by the State Geological Survey" (Hittell 1997:74). Brewer left the Survey in 1864 and took up a professorship at Yale University. His field notes are preserved at Harvard's Gray Herbarium and his journal was published in 1930 as, *Up and Down California in 1860–1864* (Farquhar 1930).

Another German-born botanical enthusiast, Henry N. Bolander (1831–1897; Fig. 6D), arrived in San Francisco in 1861. Trained as a Lutheran clergyman, and a schoolteacher by profession, Bolander had already botanized in the midwestern United States. In Ohio, he had been influenced by bryologist Leo Lesquereux, and was to maintain a life-long interest in mosses (Ewan 1953). He came to California with hopes that the climate would be beneficial to his health (Jepson 1898). He soon became acquainted with Kellogg, Behr, Bloomer and others at the California Academy of Sciences, and collected specimens in the vicinity of San Francisco. His name first appears in Academy records at a meeting in 1862; he was elected curator of botany from 1865–1867 and again in 1871; he was corresponding secretary in 1866 and 1868 (Hittell 1997).

With Brewer's resignation from the State Geological Survey in 1864, Bolander was selected to succeed him as botanist of the Survey.³⁰ In this capacity he collected fungi, lichens, algae, bryophytes, and vascular plants in many regions of California (Jepson 1898, Ewan 1953) and his specimens were widely distributed (Thomas 1961a). The Survey suffered from continual financial setbacks. In 1867, Bolander noted that he, Kellogg, and Behr had withdrawn from taking part in the Survey's activities because of the poor treatment accorded its director, J.D. Whitney, by the state's lawmakers (Leviton and Aldrich 1997).³¹ A set of the Survey's plant collections was originally intended for the Academy's herbarium (Ewan 1955), and many (or all) of Bolander's collections were certainly deposited there (*cf.* Curran 1885), but it is not known to what extent Brewer's collections were deposited at the institution. Among the type collections currently extant at the Academy, there are collections of Bolander and Brewer (Figs. 3C–D, 7A–B).³²

One of Bolander's major botanical interests was Poaceae; he often presented papers on grasses at Academy meetings and he published several contributions concerning that family in the Academy's *Proceedings*. Bolander's (1870) *A Catalogue of the Plants Growing in the Vicinity of San Francisco*, was the first comprehensive listing of plants from the San Francisco Bay Area. About 1,300 species were recorded from an area centered on San Francisco, but including localities in Contra Costa, Monterey, Napa, and Sonoma counties.

Following his departure from the Survey, Bolander continued to collect plants throughout Cal-

ifornia. He had become a teacher in San Francisco schools in 1866, and upon being elected State Superintendent of Schools in 1871, he took advantage of his travels in that capacity to augment his botanical collections (Jepson 1898). Indeed, while associated with the Academy, Bolander corresponded and exchanged plants with botanists in many distant parts of the world. These exchanges greatly increased the number of foreign plants in the herbarium, at very little cost to the institution (fide H.N. Bolander archives, C.A.S. Special Collections).

Bolander's last recorded interactions at Academy meetings were in 1874 (Hittell 1997). He departed California in 1878 for extensive foreign travels (e.g., Guatemala), and he settled in Portland, Oregon upon his return to the Pacific Coast in 1883 (Jepson 1898). In a sad note to John Lemmon dated 12 August 1889, Bolander wrote from the Bishop Scott Academy, "A Boarding and Day School for Boys," in Portland: "I have not been able to do anything in a study I loved more than any other. Envy and hatred cut me down and condemned me to inaction. But in spite of all this, Science is Science, and Botany is Botany and whosoever promotes it, has my heartfelt sympathies" (John and Sarah Lemmon Collection, archives of University and Jepson herbaria, University of California, Berkeley; information supplied by R.G. Beidleman). Asa Gray named a genus of Saxifragaceae, *Bolandra*, in his honor. Jepson (1898) and Conmy (1958) provided biographical accounts of Bolander that focused, respectively, on his botanical and educational endeavors.

Gustavus A. Eisen (1847–1940; Fig. 8A) was born and educated in Sweden, came to the United States in 1872, and joined the Academy in 1874 (Ewan 1953). There, he was a prominent zoologist, but like so many other nineteenth century naturalists, his interests were myriad and included botany, horticulture, helminthology, archaeology, and geology. Although he is not known to have served as curator of botany, he was listed as curator of biology in 1897 and apparently as curator of invertebrate zoology in 1900 by Hittell (1997). The papers he presented at Academy meetings were sometimes on botanical topics (Hittell 1997). Eisen had a longtime interest in the cultivation and promulgation of the Smyrna variety of edible fig (*Ficus carica*). In 1901, he published an important treatise on the history, varieties, culture, and curing of edible figs (Eisen 1901). He collected plants in California; he participated in Academy expeditions to Baja California in 1892, 1893, and 1894 (Ewan 1953); and he donated a number of botanical books to the Academy in 1891 (Hittell 1997). *Eisenia*, a genus of algae, was named by J.E. Areschoug in his honor.

Harvey W. Harkness (1821–1901; Fig. 8B) was born in Pelham, Massachusetts and received a degree in medicine from the Berkshire Medical College of Massachusetts in 1847. After an overland journey, he arrived in California in 1849 where he practiced medicine until his retirement in 1869. He was first elected to membership in the Academy in 1871, to the vice-presidency in 1878, and the presidency in 1887.³³ Harkness served as curator of fungi in 1896 (Hittell 1997), and his botanical studies and Academy presentations were devoted primarily to fungi (especially truffles) of the Pacific Coast.³⁴ He published numerous papers concerning fungi in the Academy's *Bulletin* and *Proceedings* between 1884 and 1899. In 1891 he donated his personal collections (containing more than 10,000 specimens, including many fungal types as well as specimens acquired by purchase and exchange) to the Academy's herbarium (Anonymous 1891a; Hittell 1997).³⁵ Two genera of fungi, *Harknessia* M.C. Cooke and *Harknessiella* P.A. Saccardo, commemorate the Academy's best known mycologist. Additional biographical information about Harkness was published in Hittell's manuscript (1997) and in *Zoe* (Anonymous 1891a).

Justin P. Moore (1841–1923; no known photo)³⁶ was very active in affairs of the Academy for many years. Moore was born in Augusta, Maine, but little is known of his early years. It is probable that he was the Rev. Justin P. Moore, a seminary graduate, who was sent by the Congregational Home Missionary Society to Benicia in October 1865. In Benicia (on the northern shore of the Carquinez Strait to northeast of San Francisco) Rev. Moore held services and established a Con-

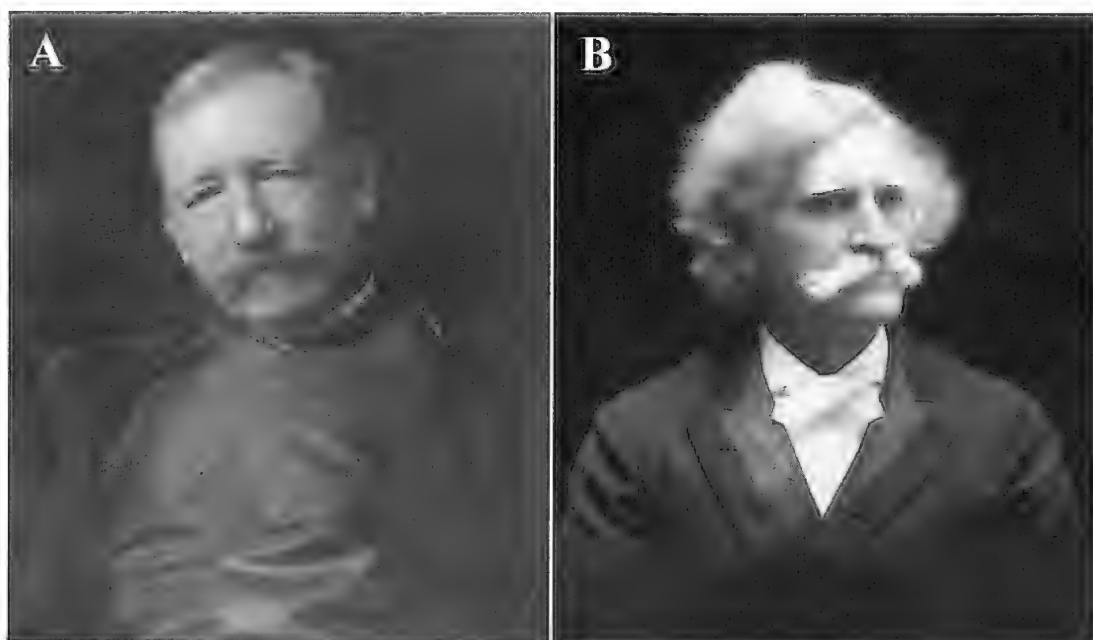


FIGURE 8. Early Academy scientists. A. Gustavus A. Eisen, (ca. 1910 photo by P.S. Bruguere, CAS Special Collections). B. Harvey W. Harkness (undated photo, CAS Special Collections).

gregational church (Anonymous 2000). Moore was elected a resident member of the Academy in 1875, curator of botany in 1882, and first vice-president in 1880–1883 and in 1886 (Hittell 1997).³⁷ His election to office in 1886 was accompanied by internal political divisions at the Academy. He resigned the vice-presidency in October 1886 and subsequently dropped out of Academy activities.³⁸ He was listed as an individual donor to the institution following the 1906 earthquake and fire (Leviton and Aldrich 1997), however, and some of his botanical books were presented to the Academy in that year as well.

Moore's interests were varied, but among botanical pursuits, he concentrated on fungi. He presented papers at the Academy concerning "parasitic plants," the "relations of fungi to disease," truffles, edible fungi, parasitic fungi, and cave fungi (Hittell 1997). With Harkness, he co-authored an important early treatise on fungi of the Pacific Coast (Harkness and Moore 1880). According to a letter from his widow to Alice Eastwood, the greater part of his collections "were gathered in Marin County...We lived in San Rafael for 19 years, and every Sunday Mr. Moore and a friend went far afield . . . seeking new specimens."³⁹ Moore resigned his Academy membership in 1889, stating that, "I do not feel that I can at present afford the nec'y expense" (letter from Moore to the Council of the Academy dated 10 January 1889 and preserved among G. Davidson papers at the Bancroft Library of the University of California, Berkeley). For the last nearly 20 years of his life, Moore was librarian and assistant secretary of the Fire Underwriters Association of the Pacific⁴⁰ (3 January 1934 letter from C.D. Moore to J.H. Barnhart, copy in Eastwood archives, C.A.S. Special Collections).

Other plant enthusiasts were affiliated with the Academy in some way during the latter half of the nineteenth century, usually as members, and often contributed specimens to its herbarium, presentations to its meetings, and manuscripts to its publications. Included among them were: Joseph LeConte (1823–1901; see Stephens 1982; Beidleman 2006), John G. Lemmon (1832–1908; see Crosswhite 1979; Beidleman 2006), Sarah A. Plummer (1836–1923; see Crosswhite 1979; Beidle-

man 2006), and Charles C. Parry (1823–1890; see Ewan 1950; Beidleman 2006). The collections and scientific publications of the earliest Academy curators and botanically oriented members, and the dissemination of these resources to botanical centers elsewhere in the United States and Europe, contributed greatly to the early knowledge of plant life in California and to the recognition of the California Academy of Sciences as a credible scientific institution.

II. FIRST FEMALE CURATOR OF BOTANY (1883–1894)

Mary Katharine Layne (1844–1920; Fig. 9A) was born in western Tennessee,⁴¹ and from there, her family moved continually westward before settling in El Dorado County, California. At 22, she married Hugh Curran of Folsom who died in 1874. In 1875, the 31-year old widow entered medical school in San Francisco. Female students were few in number at that time and they were not greeted with “open arms” at the University of California’s medical school (Ertter 2000). While there, she came under the instruction and influence of Behr (who, as noted above, taught classes at the California College of Pharmacy, which became part of the University of California’s medical school shortly after its founding in 1872). Curran received her medical degree in 1878 but, for unknown reasons, was not successful in establishing a medical practice.⁴² Encouraged by her former instructor, Behr, she spent more time at the Academy and was elected a member in 1879, only one year after the first women were elected to membership—finally putting into effect Kellogg’s resolution of 1853.⁴³ At the Academy, she continued her botanical training by working with Academy botanists, especially Kellogg and E.L. Greene (Setchell 1926; Jones 1929). With her spare time, she made herself useful in the herbarium, which she found to be “in a shocking condition” (quoted in Setchell 1926:167). She began to collect plants in 1881, and in 1883, she was appointed to a curatorship in botany and given a “salary” of \$40 per month (Hittell 1997).⁴⁴

From the beginning of her curatorship at the Academy, Curran was active in collecting plants, reorganizing and generally improving the Academy’s herbarium, and presenting papers to the membership (Setchell 1926; Thomas 1961a; Twisselmann 1967; Hittell 1997). She was also instrumental in providing publication outlets for scientific papers. She was influential in instituting the *Bulletin of the California Academy of Sciences*,⁴⁵ for which she served as acting editor (Setchell 1926; Hittell 1997), and later the private journal *Zoe*, which allowed for “freer scope to discussion and criticism” and which “was begun for me by Mr. Brandegee and Dr. Harkness” (quoted in Setchell 1926:168).⁴⁶ She also became editor of the newly revived *Proceedings* in 1888 (Hittell 1997).⁴⁷ Her article in the first volume of the Academy’s new *Bulletin* was an important list of plants described from California by her predecessors Kellogg, Behr, and Bolander (Curran 1885). In it, she attempted to “identify” these species and match them to pertinent and extant materials in the herbarium.

Edward L. Greene (1843–1915; Fig. 10) is best known as the first professor of botany at the University of California (from 1885 to 1895), but he was previously affiliated with the Academy, first as a member (1874) and subsequently as a curator of botany (1884–1887). Greene was born in Hopkinton, Rhode Island and developed a lifelong interest in plants as a small child. After receiving a bachelor’s degree from Albion Academy, he was a schoolteacher for several years (McIntosh 1983). Greene first came to California in 1874 from Colorado where he had become an Episcopalian clergyman, but his true calling was collecting plants. He came to know the Academy and its botanists during the year or so that he fulfilled his ministerial duties in Vallejo (Ewan 1953).

Following pastoral stints in Colorado and New Mexico, in 1881 Reverend Greene took a position at St. Mark’s Episcopal Church in Berkeley and began to make extensive use of the Academy’s herbarium in connection with his botanical avocation (Ewan 1953). There he worked along-



FIGURE 9. A. Mary Katharine Layne (Curran) (Brandegee) (undated photo, UC Herbarium Archives). B. Townshend S. Brandegee (undated photo, UC Herbarium Archives).

side Curran and presented papers at the Academy's meetings. In 1885 Greene took up duties at the University of California but continued to spend time at the Academy's herbarium. After assuming his professorship in Berkeley, Greene was twice reappointed curator of botany at the Academy, served on the organization's publications committee, presented papers at members' meetings, and contributed to the Academy's publications (Hittell 1997).

After a decade at the University of California, Greene moved to Catholic University in Washington, D.C. His personal herbarium was ultimately deposited at the University of Notre Dame. Numerous accounts of Greene's life and botanical work have been published (listed by Thomas 1969; see also Constance 1978; McIntosh 1983; McVaugh 1983; Ertter 2000; Beidleman 2006), and Kistler (1936) provided a bibliography of his botanical writings.⁴⁸ Kuntze named the genus *Greeneina* (Moraceae) in his honor.

The brief period during which the minister



FIGURE 10. Edward L. Greene (undated photo, UC Herbarium Archives).

and the former physician were prominent botanists at the Academy must have been a fascinating time. They appear to have been supportive of one another in their botanical efforts and they even conducted fieldwork together (Ertter 2000). Not only was Kellogg still active at this time, but mycologists Moore and Harkness and Curran's mentor, Behr, were so as well. In fact, Moore and Curran were both curators of botany in 1883; and Greene and Curran were both curators of botany from 1884–1887. With Greene's departure to the University of California and the deterioration in their opinions of one another's abilities (see below), both Curran and Greene came to play prominent roles in California's botanical politics. From 1888–1889, Curran and Hasbrouck Davis were both curators of botany; and in 1890, she⁴⁹ and Volney Rattan were jointly curators of botany.

Hasbrouck Davis was elected as a resident member of the Academy in 1887 (Hittell 1997), and he appears to have resigned his membership in 1890 according to unpublished archival files of the institution. These files also note that he was joint curator of botany for two years with Curran. His interests and activities remain unknown.⁵⁰

Volney Rattan (1840–1915; Fig. 11B) was born near Madison, Wisconsin, studied at the University of Wisconsin, and arrived in California in 1861. He became a schoolteacher and taught, successively, in Placerville, Santa Cruz, and San Francisco. He taught science at the Girl's High School in San Francisco from 1876 to 1889, and from 1889 to 1906 he taught botany at the California State Normal School in San Jose (all from Jepson 1928). He was elected to membership at the Academy in 1889 (Hittell 1997) and was listed as a curator of botany (along with K. Brandegee) for 1890 in unpublished archival records at the institution. He collected in central California, and his herbarium of about 2,000 specimens was acquired by Stanford University in 1904 (Thomas 1961a). He was author of several popular botanical textbooks, i.e., *West Coast Botany*, *Exercises in Botany for the Pacific States*, and *A Popular California Flora, or; Manual of Botany for Beginners*, the latter of which appeared in numerous editions.

The decade of 1875 to 1885 has been described as a time of internal dissensions at the Academy (Ewan 1955). As noted by Ewan (1955), University of California botanist (and Greene protégé) W.L. Jepson contended that Curran "engineered" these dissensions, whereas fellow Berkeley professor and phycologist W.A. Setchell perceived her actions as disinterested. Curran undoubtedly possessed a strong-willed personality, and she was apparently actively involved in internal Academy politics during her curatorial tenure at the institution.⁵¹ According to Academy member C.C. Parry (in a letter to S.B. Parish, quoted in Ewan 1955:32): "Acad[em]y affairs as you will infer are run *a la Curran* and nobody else has anything to say in the matter—Greene draws off to Berkeley—how long this state of things may last *quien sabe*. I enclose Harkness's inaugural written as I understand by Curran." Indeed, by 1884 the state of institutional affairs had deteriorated to the point that an Academy president later remarked, "Our herbarium was already nearly destroyed by insects and almost entirely useless for lack of classification" (O'Brien 1947).

Coincident with Greene's departure to Berkeley in 1885, Townshend S. Brandegee (1843–1925; Fig. 9B) arrived in San Francisco and according to Marcus E. Jones (Jones 1933:15), "Mrs. Curran fell 'insanely in love' with Brandegee, as she put it in a letter to her sister. It was surely a droll affair, a most intensely masculine woman desperately in love with the most retiring and effeminate man, and both of them dead in earnest about it..." Brandegee was born in Berlin, Connecticut to a prominent family. Although he studied some botany and worked in the herbarium at Yale, he graduated in civil engineering and went to Colorado as a surveyor. While there, and in other states, he took the opportunity to collect plants and send them to the major Eastern botanists (Setchell 1926). Soon after coming to California, Brandegee became an active member of the Academy and, as noted by Setchell (1926), the institution and its botanists influenced him to become more of a self-reliant scientist (e.g., publishing his own observations and data) than a mere

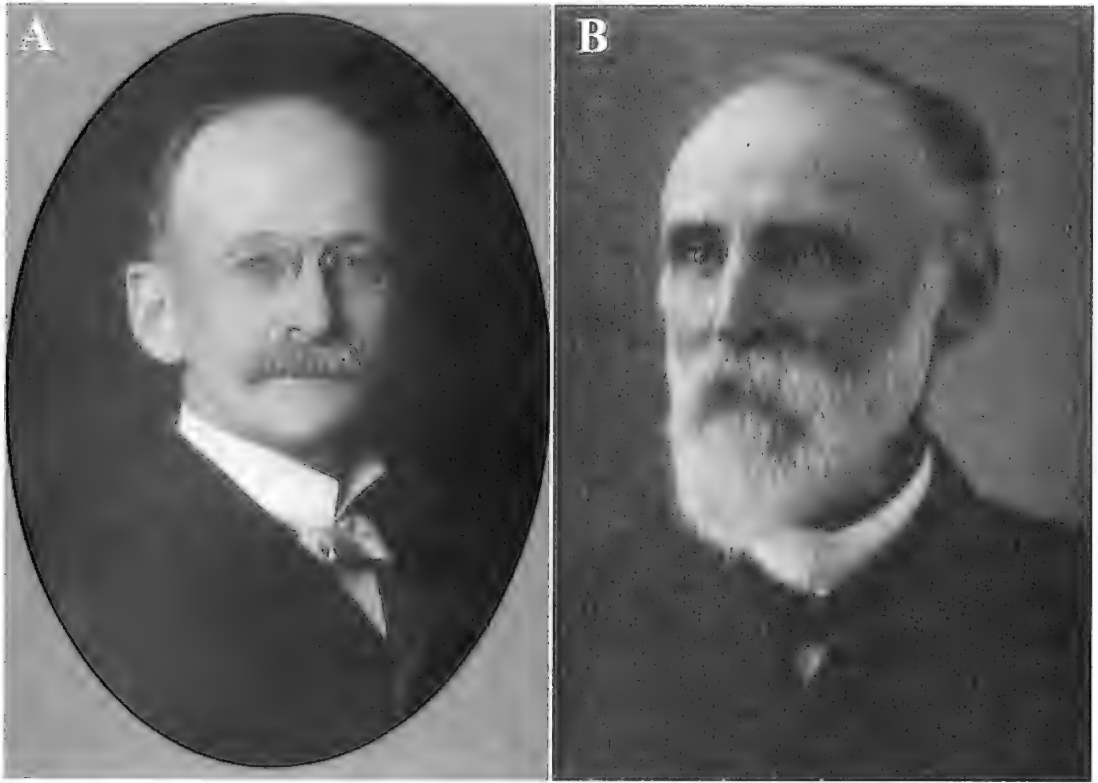


FIGURE 11. A. William R. Dudley (undated photo, Dept. Botany "biography files"). B. Volney Rattan (from *Madroño* 1:168, 1928).

collector for others. The availability of Brandegee's personal herbarium and library (Chickering 1989) was undoubtedly a significant resource for botanists working at the Academy. After becoming involved with the Academy and Curran, he often traveled to Baja California in order to collect and study plants in that botanically little-known peninsula. Although he also collected plants in much of California, parts of the western United States, and various regions of Mexico (Setchell 1926), he is best known for his extensive work in Baja California. Despite his being a member of the Academy (having been elected in 1889), corresponding secretary in 1893, and editor of volume two of the second series of the *Proceedings*, Brandegee was never a curator on the Academy's staff.

Curran and Brandegee married in 1889 (she becoming Mary Katharine Layne Curran Brandegee, often called "Kate;" and he being referred to as "Dolly," at least by his wife) and for their honeymoon, they made a collecting trip from San Diego to San Francisco, a distance of 500 miles, on foot! The botanical Brandegees (Fig. 12) would make additional walking trips to collect plants in their years together (Setchell 1926), but it is doubtful that any were of comparable length. With T. Brandegee's independent means,⁵² the couple was largely free from financial worries and founded the journal *Zoe* in 1890 (Fig. 29). According to Jones (1933), K. Brandegee was the "inspiration and the force" behind *Zoe*. The journal was also the major outlet for her botanical writings, and when it was discontinued in 1906, she published only one further paper.

In many ways the years 1890 and 1891 were pivotal in the history of botany at the Academy. In 1891, K. Brandegee finally became the organization's sole curator of botany. The Brandegees had founded *Zoe* in 1890, and in 1891 K. Brandegee helped to initiate and operate the California



FIGURE 12. Katharine and Townsend Brandegee, photo taken during visit to T. Brandegee's family in the eastern United States (CAS Special Collections and UC Herbarium Archives).

Botanical Club⁵³ of amateur plant enthusiasts and professional botanists. The goals of the Club (usually referred to as the "Botany Club") were to bring botanists of the Pacific Coast region closer together and partly to help fund *Zoe*. Also in 1891, the Academy moved into much needed new quarters on Market Street, a few blocks from Union Square in the heart of downtown San Francisco (Fig. 13A).⁵⁴ Thanks in part to Bloomer's efforts, philanthropist James Lick had given the Academy the land, and subsequently a portion of his estate allowing for the erection of two buildings. The one facing Market Street was rented to businesses in order to generate income for the institution and the one in the rear served as a public museum and a site for collections and research scientists on the upper floors. In the museum building, marble stairs led up from the open public court to tiers of rooms that opened onto balconies with brass and wrought-iron railings. The Department of Botany⁵⁵ and the Brandegees were on the sixth floor (Fig. 13B). During the move to the new facilities, the Brandegees became acquainted with a visiting Colorado botanist and former school-teacher, Alice Eastwood, who was making her first trip to the West's leading botanical center.

Katharine Brandegee's often caustic and sarcastic book reviews and comments about contemporary botanists (especially her former colleague, E.L. Greene) rival those of Marcus E. Jones.⁵⁶ Sometimes while praising the work of one botanist, she could not help but criticize another (e.g., see Thomas 1961a:153). Although Greene had been a close co-worker with her in her early days at the Academy, K. Brandegee's subsequent criticisms of his work are well known. Indeed, she published in *Zoe* a lengthy paper (Brandegee 1893b) highly critical of Greene's published botanical contributions. In reviewing Greene's (1894) *Manual of the Botany of the Region of San Francisco Bay*, she wrote, "The title should have been *A Phanerogamic Flora of — counties in the State of*

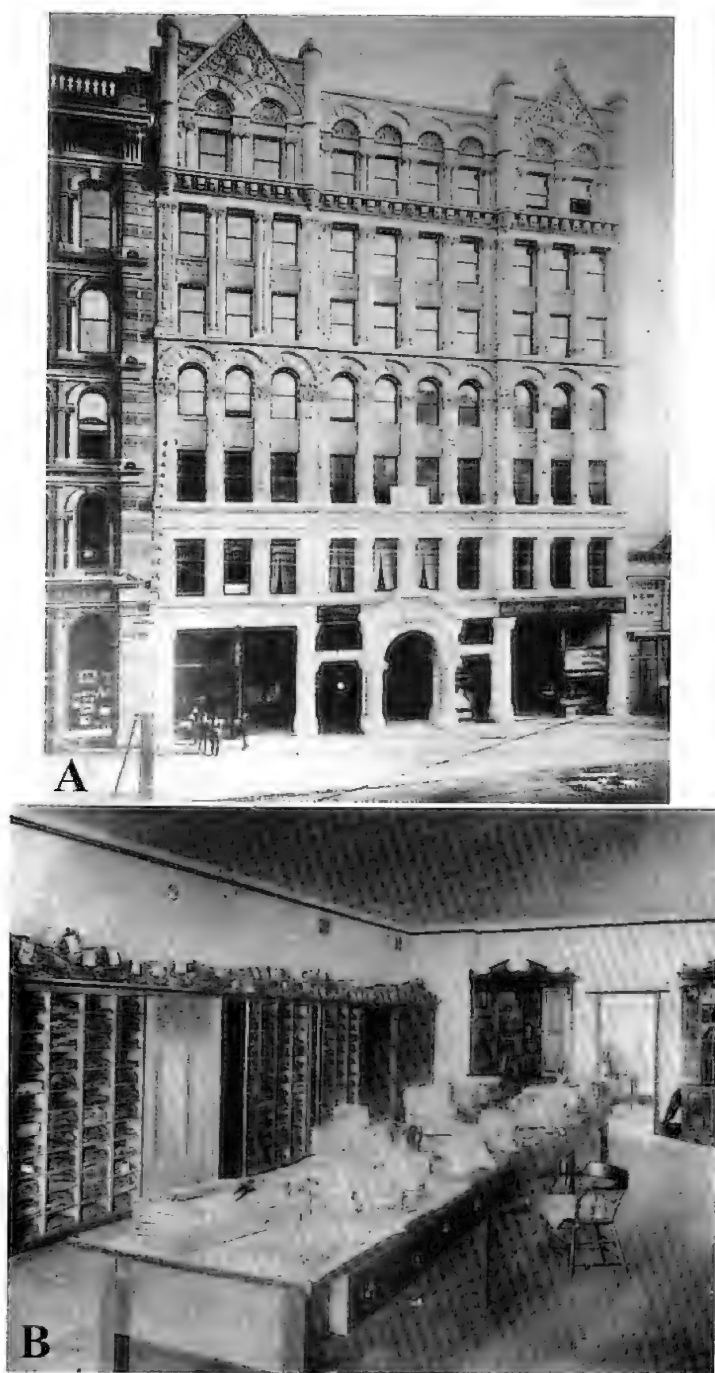


FIGURE 13. California Academy of Sciences complex. A. Academy's building on Market Street, between 4 and 5th streets. The estate of James Lick funded the Academy's commercial building on Market Street and an adjacent museum and collections building connected to and behind this one. The Department of Botany moved into the latter building in 1891 (1891 photo, CAS Special Collections). B. Herbarium on sixth floor of museum building, directly behind Market St. building (from *Californian Illustrated Magazine* 3(2):230. 1893, photo by C.F. Holder, CAS Special Collections).

California, omitting Typhaceae, Lemnaceae, Naiadaceae, Alismaceae, Juncaceae, Cyperaceae, Gramineae, Coniferae and numerous species in other orders; with thirty 'new species' none of which are new, and nearly all vaguely characterized both as to character and station; and with every change of name which the author's present knowledge admits" (Brandege 1894:417).⁵⁷ Greene apparently returned her vitriol only in private, referring to her as a "she devil" (Jones 1933). It remains unknown whether the mutual antagonism between these prominent California botanists resulted from K. Brandege's political maneuvering at the Academy as suggested by Jepson (1933) or were primarily the result of her critical nature toward scientific work that did not conform to her standards or ideas (Setchell 1926). Ewan's (1942) suggestion that her vitriolic criticisms of Greene were likely the result of unrequited love was denounced by Herre (1960). Whatever caused their mutual antagonism, it did not prevent them from interacting professionally and socially in their later years (Ertter 2000, *q.v.* for additional insight and speculation into their often stormy relationship).

Katharine Brandege's botanical activities were confined almost exclusively to California (Thomas 1969), where she collected widely.⁵⁸ She was especially interested in the plants of San Francisco and published the first comprehensive catalogue of plants occurring in the county (Brandege 1892a, 1892b). These activities complimented those of her husband, who collected primarily in Baja California following their marriage (Thomas 1969). Regarding their collecting habits, Twisselmann (1967:141) noted that "both of the Brandegees were careless collectors; any records unique with them must be viewed with suspicion as localities and dates are often obviously wrong." This sentiment is backed up by the errors and problems with labels noted by Ewan (1942). Ewan (1955:33) further noted that K. Brandege recorded only the briefest data on specimen labels, "as if she intended to stymie another collector revisiting her station!"⁵⁹

Like her mentor Behr, K. Brandege was an early Darwinist and proponent of experimental systematics (Ertter 2000). In her collecting activities, she paid careful attention to morphological variation and developmental stages of plants (Setchell 1926). Useful insight into her working methods and taxonomic philosophy was provided by Setchell (1926:166), undoubtedly gleaned from her post-Academy days in Berkeley: "Mrs. Brandege had many projects in hand at which she worked most industriously, now at one, now at another. She accumulated much material in the way of fragments of types or other critical specimens already published upon and prepared many notes, but she brought little to completion. She was never satisfied with her efforts. She projected a flora of California but her ideas as to species were so broad at times that Mr. Brandege sometimes humorously remarked that he thought that her flora would finally contain only a single species." K. Brandege never completed the floristic account of California's plants that she was obviously in an ideal position to write, and because she depended largely on her memory, little of her knowledge survived her (Jones 1933).⁶⁰

Following their marriage in 1889, the Brandegees based their studies at the Academy for the next five years. The herbarium continued to grow. In 1893, it was reported that the collection was rapidly increasing in size, with at least 20,000 specimens having been added between January and July of that year (including the private collection of George Thurber⁶¹ (Anonymous 1893).

In 1894, the Brandegees relocated both themselves and their personal library and plant collections to San Diego where they built a private herbarium and botanical garden on a mesa above that city.⁶² Twelve years later, the Brandegees returned to the Bay Area shortly after the San Francisco earthquake in 1906.⁶³ They settled in Berkeley, donated their herbarium and botanical library to the University of California, and worked out of the herbarium there until their respective deaths (Setchell 1926).⁶⁴ After leaving the Academy, the Brandegees continued to collect plants⁶⁵ and publish botanical papers for many years to come. Setchell (1926) published adjoining biographies

(with autobiographical information included therein) and bibliographies of the Brandegees. Other biographical information on K. Brandegee was provided by Jones (1929, 1933), Crosswhite and Crosswhite (1985), Bonta (1991; who notes the presence of some of Brandegees's letters at the Field Museum in Chicago, the Gray Herbarium in Cambridge, and herbaria at the University of California in Berkeley), and Ertter (2000). Useful itineraries and gazetteers for the Brandegees were provided by Ewan (1942) and Moran (1952). The genus *Brandegea* Cogniaux (Cucurbitaceae) was described in honor of T. Brandegees.

III. EASTWOOD ERA AND A NEW BEGINNING (1891–1949)

It was during the move to the Academy's new, "fire-proof" quarters on Market Street in 1891 that a 32-year-old former schoolteacher and self-trained botanist from Colorado named Alice Eastwood (1859–1953; Fig. 14A) first visited the institution. Eastwood had come to meet T. Brandegees, whose botanical work in Colorado was well known to her, and to show him the plants that she had collected the previous year in southern California (Wilson 1955). Eastwood and the Brandegees became quick friends and field companions during trips in the San Francisco Bay area. Both Brandegees were sufficiently impressed with her that she was invited to return to San Francisco later in the year to help K. Brandegees organize specimens in the new herbarium facilities. She became a member of the Academy and the California Botanical Club in April 1892. Later that year, K. Brandegees encouraged Eastwood to move permanently to San Francisco and become joint-curator in the Department of Botany. The aspiring botanical writer accepted the offer and arrived in December



FIGURE 14. Alice Eastwood. A. Shortly after arrival in San Francisco (undated photo, CAS Special Collections). B. Standing by *Eastwoodia elegans* Brandegees at 79 years of age (1938 photo by J.T. Howell in Hospital Canyon near Tracy, CAS Special Collections).

1892. In order for Eastwood to be hired as joint-curator, K. Brandegee gave up her salary, which was then paid to her new colleague (Wilson 1955). This generous gesture toward a younger colleague would not be lost on Eastwood.

Eastwood was born in Toronto, Canada and spent her early years on the grounds of the Toronto Asylum for the Insane where her father was steward.⁶⁶ An interest in plants was initially nurtured by her uncle in his large garden and subsequently by a priest at a garden in the convent to which she had been sent when her father's business failed. At age 14, she moved to Denver, Colorado to rejoin her father. Following graduation from East Denver High School in 1879, Eastwood became a teacher and an avid naturalist during the summer vacations. She explored various parts of the state, collected plants, and taught herself basic botanical science. When her finances and real estate investments permitted a small independent income, she devoted herself entirely to botanical pursuits and hoped to become a botanical writer.⁶⁷

In 1894, when K. Brandegee retired from the Academy and moved with her husband to San Diego, Eastwood was left in charge of both the herbarium and the Botany Club.⁶⁸ To augment the Academy's botanical resources, she began collecting plants very soon after taking up her curatorship. Many of the costs of her early collecting trips came out of her \$75/month salary and her own independent personal income from property she owned in Colorado (Wilson 1955).⁶⁹ She collected throughout the Bay Area and farther afield in California.⁷⁰ As a result of her activities, the herbarium steadily increased in both size and value (MacFarland et al. 1949).⁷¹

From its beginnings organization of the herbarium seems to have been somewhat haphazard by current standards. In trying to identify species and locate type specimens of California plants described by her predecessors, Curran (1885) had noted that their material was often scattered and fragmentary and that the types of many species had disappeared from the herbarium. The apparent "loss" of Bloomer's herbarium (see above) probably also reflected poorly upon the organization and operation of the herbarium. Eastwood meticulously organized Harkness's fungal collections and mounted collections of vascular plants. In addition to increasing the plant collections, one of the many curatorial activities that Eastwood undertook was to begin separating types from the herbarium in the event of fire within the building. These were placed into a lightweight case that could be lowered out of a window in an emergency (Wilson 1955). Like her predecessor, Eastwood assisted with the editing of *Zoe* and later helped edit other journals (e.g., *Erythea*).

Eastwood lived in a loft on San Francisco's Nob Hill, and walking to work each day, she often collected the weeds that grew among the cobblestone streets. This activity ultimately led to a publication and a slight altercation with Willis Jepson, a former student of and successor to Greene at the University of California. Eastwood sent her paper, titled "A Flora of the Nob Hill Cobblestones," for publication in Jepson's journal *Erythea*. Prior to publication, and unbeknownst to her, he altered her title to, "The Plant Inhabitants of Nob Hill, San Francisco." This substitution was not appreciated by Eastwood, who made a hand-written annotation in her copy of the journal (Fig. 15A). She was not to be denied, and in her retirement many years later, she expressed herself in print when the paper was republished under her original title and with an explanation in her foreword (Eastwood undated; Fig. 15B). The relationship between Brandegee's handpicked successor at the Academy and Greene's former student in Berkeley was to remain civil, but they were hardly close colleagues.⁷² Indeed, Eastwood carried on a detailed and mutually respectful correspondence with Greene following his departure from the University of California (see Duncan 2006). Eastwood appears to have been somewhat more capable of making friends of those with whom she disagreed than her mentor and colleague K. Brandegee. Her many friends would become essential to her future in systematic botany and the Academy's herbarium.

On 18 April 1906, Eastwood was awakened shortly after 5:00 in the morning by an earthquake

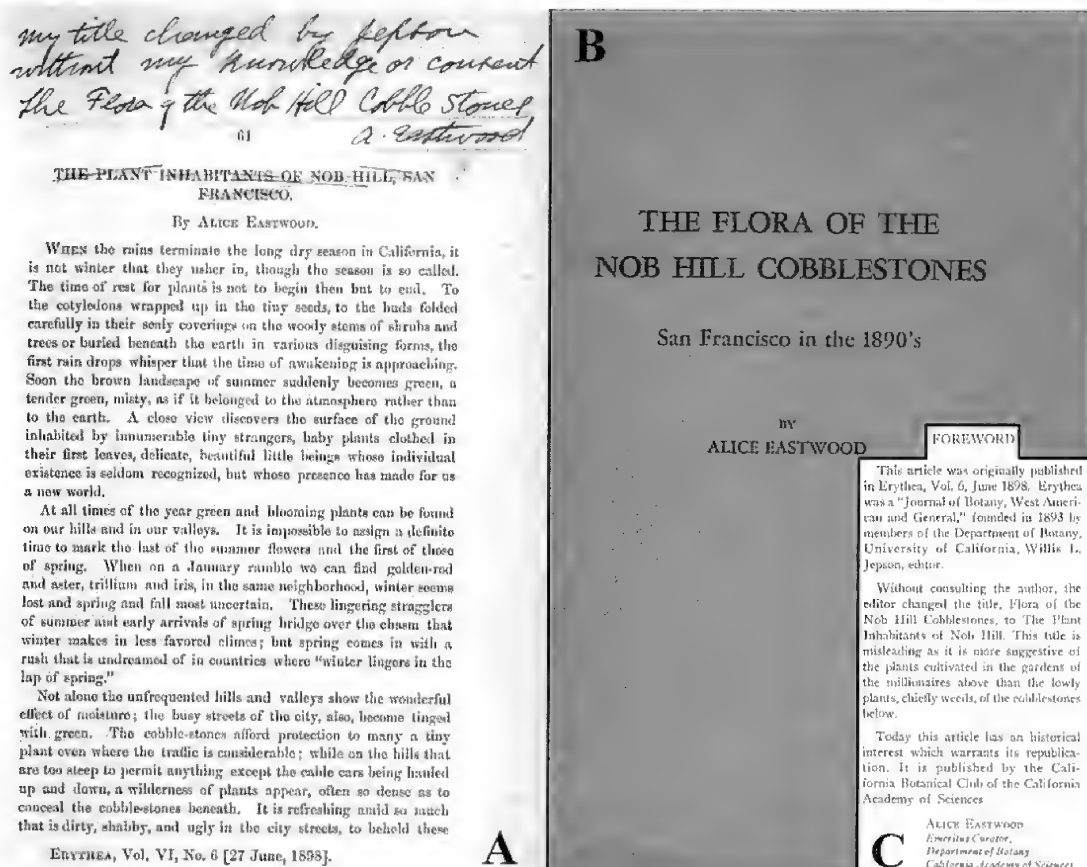


FIGURE 15. A. Eastwood's copy of the journal *Erythea* with her 1898 article on the plants growing among the cobblestone streets of Nob Hill (CAS Library). B. Eastwood's subsequent republication (with explanation in the foreword) of her article (Dept. Botany "biography files").

that shook San Francisco. Nob Hill is bedrock and little damage was sustained in her rented rooms. After eating breakfast and preparing a lunch, she started off for the Academy as usual. Approaching Market Street, the Academy's buildings appeared to be intact, but she could see fire coming up an adjacent street. The magnitude 8.3 temblor had broken the city's gas lines and water mains and fires were raging out of control. When she was finally able to get into the museum building with the help of a young friend, Robert Porter, whom she had encountered on the street, she found that the marble staircase leading up to the collections was largely destroyed. The iron railings were secure, however, and she and Porter made use of them to climb up to the herbarium on the sixth floor. The case containing the type specimens that Eastwood had been segregating from the herbarium during the previous year had been damaged by the earthquake and could not be evacuated as originally envisioned. So Eastwood placed specimens from the case into an old work apron, fashioned a cord from ropes and string (or curtains in one version) long enough to reach the first floor, and climbed back down the railings. Using the cord, Porter lowered the specimen-filled apron to Eastwood several times until all of the 1,497 specimens⁷³ that had been segregated were on the ground level. The only personal item that she saved was her Zeiss lens (Fig. 16A), which she slipped into her pocket. Eastwood and Porter located a wagon and driver that would carry the herbarium specimens and other items that had been gathered in the meantime by other Academy



FIGURE 16. Alice Eastwood. A. Curator Eastwood in the herbarium on her 80th birthday (1939 photo, CAS Special Collections). Curator Emeritus Eastwood at age 93 at Tilden Park (1952 photo by F.O. Pearse, CAS Special Collections).

staff. As fire approached the building, Eastwood climbed up on the wagon and directed the driver to the house where she rented rooms on Nob Hill. Behind her, in the bed of the wagon, was all that would remain of 53 years of botanical collecting and the largest herbarium in the western United States. The firestorm destroyed the Academy's buildings and their contents (Fig. 17).⁷⁴ Eastwood had to move the bundles of specimens twice more before they were finally safe from the spreading flames.⁷⁵ She ultimately had them transferred to the vault in the Crocker Bank for safekeeping (Wilson 1955). Her living quarters and most of her personal possessions did not survive the fires. In a letter to E.W. Nelson of the Smithsonian Institution (quoted in *Science* magazine of 25 May 1906), Eastwood wrote:

I do not feel the loss to be mine but it is a great loss to the scientific world and an irreparable loss to California. My own destroyed work I do not lament, for it was a joy to me while I did it, and I can still have the same joy in starting it again. The kindness of my friends has been great. I feel how very fortunate I am; not at all like an unfortunate who has lost all her personal possessions and home...

Looking back on the tragedy after more than three decades, then Academy director Robert Miller wrote (1942):

That anything at all was saved was due especially to Miss Eastwood, then as now [1942] the Academy's curator of botany, who lost all of her own possessions while attempting to save those of the Academy... It was justice in the most poetic sense that more than half a century after the Academy had voted to admit women to its activities, the book of minutes containing the record of that action, along with other documents and specimens of inestimable value, should have been saved through the energy and resourcefulness of a woman curator.

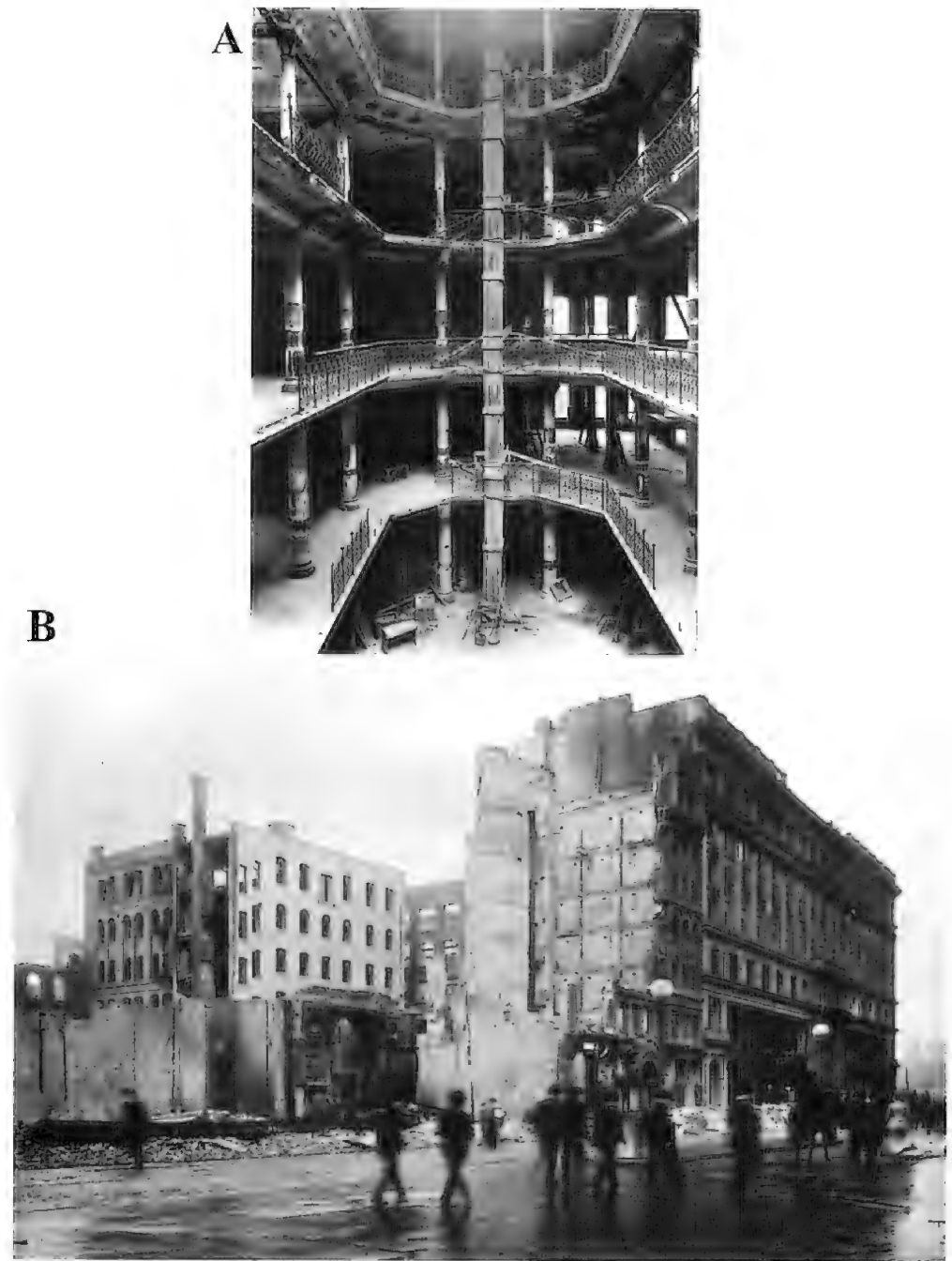


FIGURE 17. A. Interior of Academy's museum building in 1906 after the earthquake and fire but prior to demolition (1906 photo, CAS Special Collections). B. Academy's buildings from Market Street following the earthquake and fire, and during demolition (1906 photo by F. Anderson, CAS Special Collections).

The Academy's Department of Botany had been the center of botanical activity in California from its inception until its destruction in 1906. Prior to the San Francisco earthquake and fire,⁷⁶ the Academy's herbarium was the largest and most important in western North America. An inventory of the herbarium prepared in the mid-1890s (Anonymous 1896) indicated the presence of 74,767 total specimens.⁷⁷ Considering Eastwood's activities (see note 71 below), it is reasonable to suppose that by the time of the earthquake and fire in 1906 the herbarium contained at least 100,000 specimens.

After the destruction of the Academy, curators were advised to find alternate means of employment. For various periods, Eastwood accepted William Setchell's offer of working space at the University of California's herbarium.⁷⁸ Eastwood spent the decade after the earthquake and fire collecting plants (Fig. 18), traveling to domestic and foreign herbaria, working as an assistant at Harvard's Gray Herbarium, serving as the Academy's Assistant Librarian, and planning for a new Department of Botany at the Academy.⁷⁹ In spite of her activities, the future of the Academy and its Department of Botany were by no means secure. Some of Eastwood's doubts and concerns about the governance of the institution (especially its then director L.M. Loomis) were expressed in letters to her friend E.L. Greene (Duncan 2006). However, Eastwood's fears were assuaged by the Academy's longtime second vice-president Otto von Geldern who noted that although Loomis "has invariably fought the rehabilitation of this department," there would be a botanical department in the new Academy, and von Geldern expressed the hope that she would lead it (letter of 26 January 1911 from O. von Geldern to A. Eastwood in Department of Botany archives, Box 2, C.A.S. Special Collections). Indeed, in 1912, the Academy recalled Eastwood (Fig. 19) to San Francisco to begin rebuilding the herbarium in earnest (although she continued to travel and collect following her return).⁸⁰



FIGURE 18. Alice Eastwood collecting in ca. 1913, probably during trip to Warm Hot Springs in San Diego Co. (photo, CAS Special Collections).



FIGURE 19. Alice Eastwood (1912 photo by G. Eisen, CAS Special Collections).

In 1916, when the Academy reopened at its new home in San Francisco's Golden Gate Park, Eastwood was 57 years old. The specimens she had saved from the 1906 disaster, her own collections since that time, loans outstanding in 1906, donated collections from both domestic and foreign sources, and plants collected during the Academy's 1905–1906 expedition to the Galapagos Islands (Fig. 20)⁸¹ formed the nucleus of the new (and present) herbarium. With renewed vigor, she continued to rebuild the Academy's botanical resources, both in the herbarium and library. By 1918, the herbarium already contained 50,559 specimens.⁸² Under her leadership, the Botany Club provided volunteers to work as assistants in the herbarium and funds to buy books for the library. One of the selfless and continuing acts of Eastwood was the purchase, from her own resources, of books and serials (sometimes entire runs of important journals) for the library.

It is indicative of Eastwood's visionary philosophy that following the destruction of the largest collection of California plants in existence, she sought to establish a worldwide collection in its place. She remarked, "Looking forward to the future greatness of San Francisco, I wanted this new herbarium to be a great one, founded on a broad basis, a herbarium containing not only plants of North America, but of the whole world" (Eastwood 1952:205). Acquisition in 1920 of the Albert Prager Herbarium, a large and important private herbarium of plants from the Old World, was a major step in this direction.⁸³ Immediately outside of the new herbarium, she helped develop Golden Gate Park into a horticultural wonderland, where today some 8,000 species from nearly all regions of the planet are cultivated, mostly out-of-doors, on land that was previously sand dunes. To help ensure the success of the diverse plantings in Golden Gate Park, she taught classes in the evening for the Park's gardeners. Together with Park superintendent John McLaren, Eastwood successfully crusaded against destruction of the Park by proposed streetcar lines traversing it. She also



FIGURE 20. Crew of the Academy's 1905–06 Galapagos Expedition (with botanist Alban Stewart second from left) on the schooner *Academy* just prior to departure from San Francisco on 28 June 1905 (photo, CAS Special Collections).

founded and/or nurtured numerous floral and conservation organizations.⁸⁴ Meanwhile, her collecting activities throughout western North America continued unabated (Wilson 1955). By uniting these and other activities into a positive work ethic, and by benefiting from the generosity and assistance from her large circle of friends, she was enormously successful in rebuilding both the herbarium and botanical library.

At age 90, following 56 years of service to the Academy, Eastwood retired from her curatorship on her birthday (19 January) in 1949, and became curator emeritus at the institution (Howell 1954a, 1954b; Wilson 1955; Fig. 16). Specimens in the herbarium at that time numbered more than 352,000 (Miller 1949). Her botanical interests were of a general nature. This is amply reflected by her bibliography (MacFarland and Sexton 1949) of over 300 titles that includes technical botanical treatises, floristic studies, horticultural notes, ethnobotanical reports, historical accounts of botanical exploration, book reviews, and popular articles for a lay audience. Although she published articles on mushrooms, ferns, gymnosperms, monocots and dicots, she worked extensively with manzanitas (*Arctostaphylos*), lupines (*Lupinus*), Indian paint brushes (*Castilleja*), and numerous plants occurring on Mt. Tamalpais in Marin County. Undoubtedly, more has been written about Alice Eastwood than any other botanist affiliated with the California Academy of Sciences. Eastwood is commemorated in the genera *Aliciella* Brand (Polemoniaceae) and *Eastwoodia* (Asteraceae; Fig. 14B); the latter was described by the man she first came to San Francisco to meet, T. Brandegee. Additional biographical information on Eastwood is available in MacFarland et al. (1949), Dakin (1954), Howell (1954b), Gambill (1988), Bonta (1983, 1991), Rush (2003), Duncan (2006), and Leviton et al. (2006). Wilson (1955) published a detailed biographical tribute to Eastwood, from which much of the above information is derived. She also compiled a partial gazetteer and chronology of Eastwood's collecting localities (Wilson 1953).

Because of her enthusiasm for collecting plant specimens throughout the western United States,⁸⁵ her heroism in saving critical herbarium specimens from the fire following the 1906 earthquake, her perseverance in rebuilding the Academy's botanical resources, her generosity to numerous garden and conservation organizations, and her prodigious scientific productivity, Eastwood has taken on legendary status in the San Francisco Bay Area. Her accomplishments were indeed remarkable and the praise she received was much deserved. Although she left her books and many of her personal possessions (including her salvaged Zeiss lens) to the Academy, among the most important of Eastwood's legacies was her protégé, John Thomas Howell.

IV. HOWELL AND ASSOCIATES (1950–1968)

John Thomas Howell⁸⁶ (1903–1994; Fig. 21) was born in Merced, California and became the first curator of botany at the Academy to be a “native” Californian. Upon graduation from grammar school, Howell was taken by an uncle on his first trip to the Sierra Nevada. He later noted, “A love for the out-of-doors and an interest in Nature that were engendered on that trip were destined to give direction to my whole life” (Howell 1967). Each summer between 1919 and 1925, he returned to the Sierra Nevada either on vacation trips or via working at Sierran resorts. He pursued botanical studies at the University of California under Jepson and received an M.A. degree in 1927 for his study of *Lessingia* (Asteraceae; Howell 1929). He helped pay for his undergraduate education by working on an hourly basis for Jepson; much of this work was of an editorial nature (Howell 1967). From 1927–1929, Howell was the first resident botanist at the Rancho Santa Ana Botanic Garden in southern California,⁸⁷ when the Garden was still located on Susanna Bixby Bryant's ranch in Santa Ana Canyon. Bryant fired Howell from this post, for which Jepson had recommended him, because she felt that he was “not suited for a position on the Rancho Santa Ana” (Smith

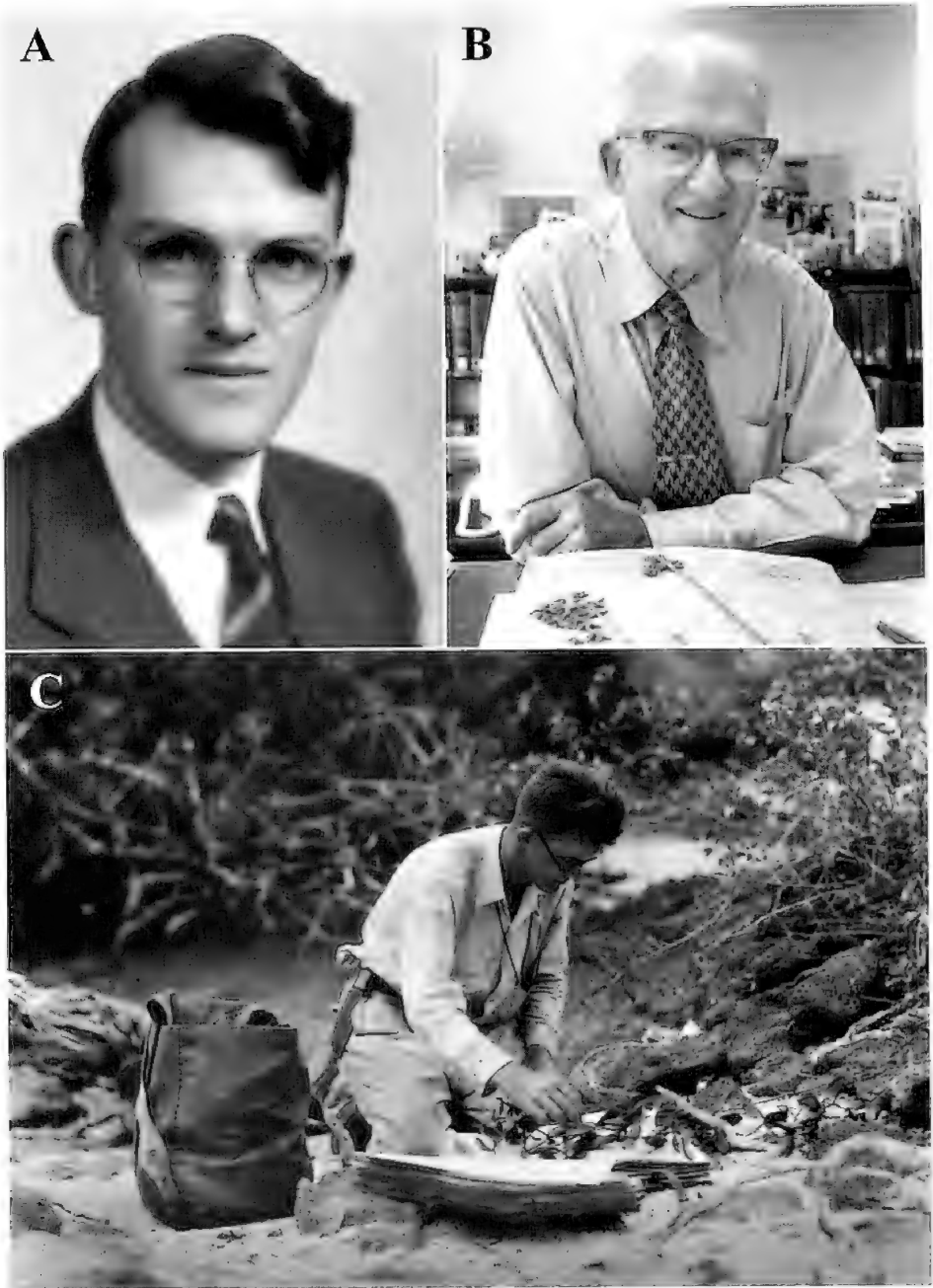


FIGURE 21. John Thomas Howell. A. Thirty-five year old assistant curator, just prior to his "Sierra Club decade" (1938 photo, CAS Special Collections). B. Eighty year old curator emeritus in his office in Golden Gate Park (1983 photo by S. Middleton, CAS Special Collections). C. Twenty-nine year old Howell collecting plants at Academy Bay on Santa Cruz Island during the 1932 Templeton Crocker Expedition the Galapagos Islands (1932 photo by T. Asaeda, Dept. Botany "biography files").

1989:12). Howell had come to know Eastwood during his visits to the Academy's herbarium in 1926 in order "to examine its rich historical collections of *Lessingia*" (unpublished typescript of 4 April 1975 by J.T. Howell, "Alice Eastwood and John Thomas Howell (mostly concerning Eastwood & Howell field work)," Howell Archives, C.A.S. Special Collections). Eastwood offered Howell a temporary position at the Academy in 1929 and a permanent one in 1930. Initially, she paid his entire salary from her own resources (Wilson 1955). He spent the next 65 years affiliated with the institution's Department of Botany.⁸⁸

Following Howell's dismissal from the Rancho Santa Ana and his taking up a temporary position at the Academy, relations with Jepson became strained. Although he returned to the graduate program in Berkeley for the 1929–1930 academic year, Howell never completed a Ph.D. directed by his undergraduate mentor as planned. With Jepson in control of the California Botanical Society and its journal *Madroño*, Howell felt it either awkward or impossible to publish there, so he suggested to Eastwood that they start their own journal. Thus, *Leaflets of Western Botany* was founded in 1932 (Fig. 29) with Eastwood supplying most of the funding and Howell taking on most of the editing.⁸⁹

In addition to their joint work on "*Leaflets*," Eastwood and Howell, often accompanied by others, collected widely in California and the western United States (Fig. 22). Together and separately, they conducted fieldwork through the Great Depression⁹⁰ and World War II. During the 1930s and 1940s, they usually personally paid the expenses of their field activities (Department of Botany archives, Box 1, CAS Special Collections.) On their joint field trips Howell did most of the collecting while Eastwood cataloged and pressed the specimens. It was, as Eastwood noted, "a grand partnership" (Bonta 1991:100). More than 10,000 "Eastwood and Howell" collections were made in Arizona, Colorado, Idaho, Nevada, New Mexico, Oregon, Utah, Washington, and in 48 counties of California during 1933–1941 (Howell 1967). By the end of his collecting days, Howell's collection numbers exceeded 54,000.⁹¹

From March to September of 1932, Howell was botanist on the Templeton Crocker Expedition to the Galapagos Islands where he collected 2,555 vascular plants on 13 of the islands (Fig. 21C).⁹² This is one of the largest and most important gatherings of plants by a single collector in the Galapagos Islands to date.⁹³ These collections formed the bases for some of the first serious revisionary studies of plant taxa with significant radiation in the Galapagos Islands. Howell's own publications on the Galapagos flora included work on Cactaceae, Amaranthaceae, *Mollugo*, *Tiquilia*, *Scaevola*, and *Polygala*. In spite of making such a rich and important tropical collection, Howell preferred to devote his efforts to studying the temperate flora of California and the western United States.

In 1939, Howell became a life member of the Sierra Club. Some years later he noted (Howell 1967:3) "For the next 10 years much of my botanical activity outside the Academy and most of my social life centered in programs connected with the Sierra Club. My natural history writings in the club "Bulletin," "Yodeler," "Nature Notes," and "Base Camp Botanics," aimed at popularizing systematic aspects of the natural sciences, particularly botany, were scarcely short of voluminous!" During this "Sierra Club decade" Howell participated in numerous Club outings for which he received plant-collecting privileges in exchange for providing natural history programs. "This cooperation, which continued through 1949, not only gave me an intimate knowledge of much of the high Sierra Nevada south of Yosemite but also gave the Academy a fine representation of alpine and subalpine Sierran plants" (Howell 1967:3).

With the retirement of Eastwood in 1949, Howell became curator (since 1930 his title had been "assistant curator") of the Department of Botany. In his first report on the activities of the Department in 1949, Howell reflected on Eastwood's tenure as curator: "It had been her experience to see

A**B**

FIGURE 22. The "grand partnership:" Eastwood and Howell. A. On Mt. Rainier, Washington in 1937 (photo by E.H. English, Dept. Botany "biography files"). B. Collecting in Mohave Desert from Leucy I, a 1931 Ford touring car, during a trip with Y. Mexia to Utah and Arizona (1933 photo by Y. Mexia, Dept. Botany "biography files").

the foremost botanical collection in western America destroyed by fire in 1906 and her privilege to rebuild the outstanding herbarium and botanical library which the Academy now has" (Department of Botany archives, Box 1, C.A.S. Special Collections). Like Eastwood before him, Howell inherited both the curatorship of the herbarium and the running of the Botany Club. Following Eastwood's retirement, he continued collecting, editing "*Leaflets*," and publishing his studies of California's plants. Howell also served as botanical editor of *The Wasmann Journal of Biology* and the *Journal of the California Horticultural Society* for several years.

When Eastwood ceased active leadership of the Botany Club in 1952, Howell assumed that

role and skillfully directed the Club's activities and nurtured its members. In 1955, showing incredible foresight, Howell suggested to its members that the Botany Club establish an endowment fund for the benefit of the Academy's Department of Botany as an expression of appreciation for the institution's "sponsorship." At its meeting of 20 January in that year, Howell passed around a paper bag and received more than \$300 in donations. In a subsequent solicitation letter to the Club's members, Howell indicated, "The fund will not only be the aggregation of dollars and cents for helping with the Academy's botanical program but will become the tangible accumulation of assets of friendship and good will felt by many for the Academy, its Botany Department, and the California Botanical Club."⁹⁴ The efforts of Howell to establish a permanent fund for botanical projects was both timely and farsighted (see note 125 below). He had previously made personal investments to secure his own retirement, and managed many of his family's business interests (Howell 1967). As Howell anticipated, the fund continued to grow and earnings from it have been used for various projects over the years. Its market value in December 2003 was about \$782,000.

Growth of the herbarium beyond the limits of its space in the research wing of North American Hall is well documented in the annual reports of the Department of Botany (Department of Botany, Box 1, C.A.S. Special Collections; Fig. 23A). For example, in 1934 Eastwood noted, "The Herbarium now numbers 220,000 mounted sheets and probably 20,000 unmounted for which there is no room in the [96] cases. They have to be stacked in bundles on tops of the cases." With a touch of humor, she added, "However, the ceiling has not yet been reached." By 1936, in their joint departmental report, Eastwood and Howell were in no joking mood. The bundles were now nearly at the ceiling. Eastwood felt compelled to hire, at her own expense, Ms. H.P. Bracelin to arrange and label the bundled specimens into a scientific sequence so that the materials would be available. They noted that, "This additional work would not have been necessary if our facilities had been adequate. The need for herbarium cases is great." Ten new cases were finally installed in 1940, but this did little to relieve the congestion in the herbarium. As a result of both the space limitations and the wartime conditions, growth of the collection slowed significantly. By 1943, only about half of the 313,481 mounted specimens were in herbarium cases; the remainder was in bundles or boxes. In 1948 an insect infestation was discovered among the 900 boxes of specimens. Eastwood made a plea for help directly to the Board of Trustees; they appropriated funds for 50 additional herbarium cases. Following that success, things looked brighter in the early 1950s: exchange activities rebounded (10,747 specimens were distributed in 1951) and in 1951 the Department was allotted additional floor space in North American Hall that relieved the overcrowded conditions. By 1955, however, overcrowding was again becoming a problem and Howell's annual reports began making a new appeal for additional herbarium cases and floor space for the Department. His hopes and arguments were soon directed toward construction of a new building at the Academy. A plan to provide a new building to house the Department of Botany and its herbarium had been revealed by Academy director Robert Miller on Eastwood's 80th birthday in 1939 (Wilson 1955). The war years interfered with both the planning and fund-raising for this project, but Eastwood occasionally contributed to the building fund and encouraged her family and friends to do so as well. On the occasion of the Academy's centennial in 1953, the trustees renewed efforts to fund the building. With a substantial gift from the family of Norman B. Livermore, the Alice Eastwood Hall of Botany was completed in 1959 (Fig. 23B).⁹⁵ This facility, which also housed the Academy's new main library,⁹⁶ included public exhibition space and allowed for the rearrangement and expansion (into 108 new herbarium cases) of the collection, which was moved from its home (since 1916) in the research wing of North American Hall (Miller 1958, 1960). The new and spacious facilities for the Department of Botany on the ground and first floors of Eastwood Hall again afforded growth opportunities for the herbarium (Fig. 23C).⁹⁷

A



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Photo: C. F. Anderson



C

FIGURE 23. Department of Botany facilities in Golden Gate Park (1915–1975). A. Howell and Minerva Hirst (Academy member) in cramped departmental quarters of research wing of North American Hall (1946 photo, CAS Special Collections). B. Exterior of Eastwood Hall of Botany building with the Department of Botany occupying the ground floor and part of the first floor; the subsequent home of the department, shown in Fig. 25, would be located in another new building to the left of Eastwood Hall (1959 photo from *Academy News Letter* 233, CAS Special Collections). C. Howell, Anita Nold-eke, and Javier Peñalosa in botanical quarters of Eastwood Hall of Botany (ca. 1967 photo by L. Ullberg, CAS Special Collections).

At the end Howell's tenure as curator, the number of vascular plant specimens in the herbarium had grown to more than 480,000 (Anonymous 1969), largely as a result of his own collections and those of the many professional and amateur botanists he influenced over the years. Howell had collected throughout California, but for some 25 years he devoted considerable time to collecting in the Sierra Nevada with the prospect of writing a flora of those mountains. Upon completion of *Marin Flora* in 1949, an account of the plants in the Sierra Nevada was projected for completion in five years (Howell 1967). Unfortunately, a flora of the portion of California that had been so important to Howell as a boy and as a young botanist was never completed. The 20 herbarium cases housing his Sierra Nevada collections⁹⁸ were incorporated into the general herbarium at the Academy during 1993–1996, after publication of *The Jepson Manual*; thus, they were not studied by many authors of treatments in that account of the state's flora (Hickman 1993).

Over the years Howell was mentor to a loyal following of amateur and professional botanists (in addition to those in the Botany Club), many of whom became associates in the Department of Botany (see Appendix II). Although the projected flora of the Sierra Nevada was not realized, numerous other local floras were completed either solely by Howell or by Howell in collaboration with his myriad associates. First, and paramount among these, was *Marin Flora, Manual of the Flowering Plants and Ferns of Marin County, California* (Howell 1949). This eloquent and popular guide was reprinted several times, revised into a second edition (with supplement) in 1970, and has undergone a major revision by Academy staff and associates. Important collaborative publications included: "Plants of the Toiyabe Mountains area, Nevada" (Linsdale et al. 1952), *A Flora of San Francisco, California* (Howell et al. 1958), *A Flora of Lassen Volcanic National Park, California* (Gillett et al. 1961), *The Vascular Plants of Monterey County, California* (Howitt and Howell 1964), "A Vegetation Survey of the Butterfly Botanical Area, California" (Knight et al. 1970), *Saint Hilary's Garden* (Howell and Ellman 1972), "A Catalogue of Vascular Plants on Peavine Mountain" (Williams et al. 1992), and *A Flora of Sonoma County: Manual of the Flowering Plants and Ferns of Sonoma County, California* (Best et al. 1996).⁹⁹ Those inspired and encouraged by Howell to produce local floristic studies include Peter Rubtsoff (1953), Ernest Twisselmann (1956, 1967), Henry Pollard (1959), Javier Peñalosa (1963), Gladys Smith (1973), Clare Wheeler (Smith and Wheeler 1992), and Gordon True (2003).

Howell published on diverse plant families (especially Asteraceae, Cyperaceae, Hydrophyllaceae, Poaceae, Polygonaceae, Rhamnaceae, and Rubiaceae) and his bibliography includes more than 500 entries. He considered his writings in and production of *Leaflets of Western Botany* to be his most important contribution to California botany. Following his retirement in 1968, the John Thomas Howell Chair in Western American Botany was established at the Academy in his honor.¹⁰⁰ By his wide-ranging botanical interests, generous nature, modest demeanor, and literary (to poetic) writing style, Howell had been the natural successor to Albert Kellogg. Passages from his *Marin Flora* (e.g., under *Eschscholzia californica* and *Brassica oleracea*) show a decided similarity in style to Kellogg's (1882) prose, which is evident throughout his "Forest Trees of California." Both botanists were equally enchanted by the state's flora.

As curator emeritus, Howell remained active in research on California plants until shortly before his death in 1994 at age 90. Like Eastwood, Howell lived a long and productive life, although much of it was in the shadow of his famous predecessor. When his time to lead the Department of Botany came, however, his dedication and productivity were equal to that of any previous curator at the Academy. The genera *Howelliella* Rothmaler (Scrophulariaceae) and *Johanneshowellia* Reveal (Polygonaceae) commemorate one of California's most prolific and generous botanists. Additional biographical information on Howell was provided by Thomas (1969), Daniel et al. (1994), Chickering (1989), and Smith (1989).

V. EXPANSIONS AND NEW DIRECTIONS (1968–2003)

The respective retirements of Eastwood and Howell each left a sizable gap in the botanical program at the Academy. Eastwood was succeeded by another energetic botanist, Elizabeth M. McClintock (1912–2004; Fig. 24A). McClintock was born in Los Angeles and spent her childhood in Arizona and southern California. She had an early interest in plants that led to a major in botany at the University of California, Los Angeles. McClintock received her Ph.D. in 1956 at the University of Michigan where she studied *Hydrangea* (Saxifragaceae) as a student of Rogers McVaugh. McClintock joined the Academy on 1 October 1948 when she was hired as a research assistant in the Department of Botany (with Eastwood paying her salary). Upon the retirement of Eastwood in January 1949, she became a curator of botany and maintained that position until her own retirement in 1977.

McClintock was the first curator of botany at the Academy to attain a Ph.D. Although her botanical interests were diverse, she was known primarily for her studies and collections of ornamental plants. Like Eastwood, she had a particular interest in the taxonomy of cultivated plants.¹⁰¹ She published numerous regional and local checklists of cultivated plants (e.g., Mathias and McClintock 1963; McClintock and Moore 1965; McClintock 1977; McClintock and Lieser 1979; McClintock et al. 1982) and was a major contributor (though largely unattributed as an author) to *Hortus Third* (Bailey Hortorium 1976). For 21 years, she was associate editor of *Pacific Horticulture* and contributed considerable text to that journal (Turner 1997).¹⁰² McClintock worked closely with the Strybing Arboretum¹⁰³ and in 1958 co-authored a list of plants cultivated there (Walther and McClintock 1958). With collaborators, she produced two floristic accounts of San Bruno Mountain, a park in San Mateo County, just south of San Francisco (McClintock et al. 1968, 1990). McClintock also was involved in local conservation efforts. Following in the footsteps of her predecessor, she was a vocal and effective opponent of a proposed plan to locate a freeway in part of Golden Gate Park, and for many years she was an outspoken critic of private efforts to develop habitat of the rare dune tansy (*Tanacetum camphoratum*) near San Francisco's Ocean Beach.¹⁰⁴

In 1977, McClintock did not desire to retire, but mandatory retirement at age 65 was in effect at the Academy at that time.¹⁰⁵ This, combined with having felt underappreciated at the Academy for studying ornamental plants, caused some resentment on her part. As a result, during the early years of her retirement, she spent much of her time working at the herbaria of the University of California in Berkeley. There, she wrote treatments of numerous families and genera for *The Jepson Manual*. With Thomas C. Fuller, an associate in the Academy's Department of Botany, she co-authored the important guide, *Poisonous Plants of California*, in 1986. Following the death in 1991 of her good friend Annetta Carter,¹⁰⁶ McClintock spent more time back at the Academy working on various horticultural projects. The most significant of these was *The Trees of Golden Gate Park and San Francisco* (McClintock 2001), an edited assemblage of her work on some of the trees grown locally. She maintained an office at the Academy from her retirement until 2000, when she was no longer able to work due to illness.

McClintock's collections are mostly from California (especially San Bruno Mountain and near Pixley in Tulare County) and from gardens. Her collections of ornamental plants built upon the Academy's already significant collection of cultivated plant specimens amassed by Eastwood and former director of the Strybing Arboretum, Eric Walther.¹⁰⁷ She also collected plants in Arizona (mostly the White Mountains and the western portion of the Grand Canyon). Autobiographical information on McClintock, based on interviews for an oral history, was published in *California Women in Botany* by the University of California's Bancroft Library (Regional Oral History Office 1987). Much of the animosity that she felt toward former Academy executive director, George

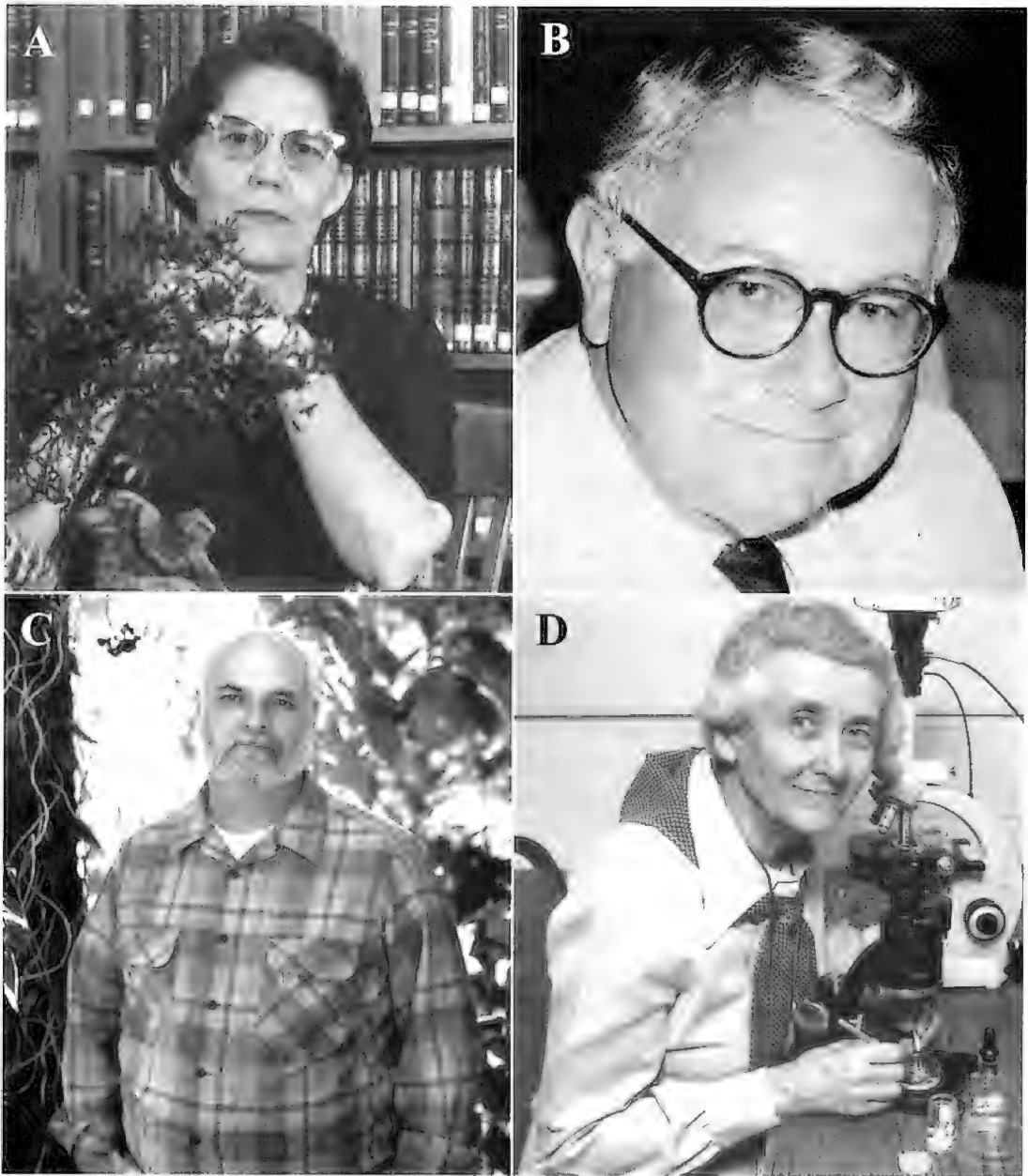


FIGURE 24. Academy curators of botany. A. Elizabeth McClintock (1961 photo, Dept. Botany "biography files"). B. John H. Thomas (undated photo, Dept. Botany "biography files"). C. Dennis Breedlove (1990 photo by S. Middleton, CAS Special Collections). D. Alva Day (1983 photo by S. Middleton, CAS Special Collections).

Lindsay, and her resultant contempt for the entire institution permeates her story.

With the retirement of Tom Howell in 1968, the Department of Botany, which had been rebuilt and fashioned by Eastwood and Howell, was poised for a major expansion of its resources, new research directions, and increased staffing. In the late 1960s, officials at Stanford University decided to eliminate their Division of Systematic Biology and dismantle their Natural History Museum.

An agreement was reached with the Academy to move Stanford's plant collections (i.e., the Dudley Herbarium or DS) to San Francisco and integrate them with the Academy's herbarium. In anticipation of this amalgamation, Stanford botanist John Thomas was appointed as a part-time curator of botany at the Academy in 1969, construction began on a new building (Wattis Hall) at the Academy's campus in Golden Gate Park in 1974 (Fig. 25A),¹⁰⁸ and compactorized storage units for housing the combined collections were funded by the National Science Foundation in 1974 (Fig. 25B–C).¹⁰⁹

Also in 1969, Dennis E. Breedlove (b. 1939; Fig. 24C) joined the Department of Botany as Howell's successor. Breedlove was born in Oakland, California, received an A.B. degree in 1962 from the University of California, Santa Barbara, and completed a Ph.D. in 1968 at Stanford University. His doctoral studies on *Fuchsia* (Onagraceae) were directed by Peter Raven.¹¹⁰ He came to the Academy from a position as research botanist at the University of California Botanical Garden in Berkeley. His studies of Mexican plants reinvigorated interest in tropical botany at the Academy and led to significant growth of the herbarium's collections. Breedlove collected primarily in California and Nevada (especially in the Sweetwater Mountains on the border between these states), Mexico (especially Chiapas, the Sierra Surutato in Sinaloa, and Baja California), and Guatemala. Throughout his career, Breedlove published on diverse plants (including taxa in the Actinidiaceae, Asteraceae, Ericaceae, Fabaceae, Gentianiaceae, Hypericaceae, Onagraceae, Scrophulariaceae, and Rubiaceae) in numerous botanical subdisciplines (including cytology, ecology, ethnobotany, evolution, and taxonomy).

Breedlove is best known for his collections and floristic studies in Chiapas,¹¹¹ the southernmost state of Mexico, and his ethnobotanical work in that state with various collaborators (Berlin, Breedlove and Raven 1974; Breedlove and Laughlin 1993). His activities in Chiapas were supported, in part, by the National Science Foundation (NSF); indeed, he was the first curator of botany at the Academy to receive direct NSF funding for his research.¹¹² Breedlove undertook many of his collecting trips to Chiapas accompanied by other Academy botanists (e.g., Almeda, Anderson, Bartholomew, Bourell, Daniel, Keller, McClintock), scientists from other herbaria (e.g., G. Davidse, R.L. Dressler, E. Palacios, P.H. Raven, A.R. Smith, J.L. Strother, R.F. Thorne), horticulturists (e.g., D. Mahoney, J. Sigg), and others (e.g., C. Burns, D. Axelrod, A. Ton). In the mid-1980s, while studying *Quercus* for a treatment of Fagaceae for the *Flora of Chiapas*, Breedlove developed an interest in this genus and collected specimens of it from many regions of Mexico. Although he amassed an enormous collection of Mexican oaks, knew the species well in the field, and had drawings prepared of several new taxa, he never published the results of his studies on the genus.

Following his retirement in 1994, Breedlove was appointed curator emeritus in the Department of Botany. In retirement, Breedlove devotes his time to pursuits other than systematic botany and is rarely seen or heard from. His primary (and a truly remarkable!) contribution to botany is undoubtedly the more than 72,000 collections that he made, mostly in Chiapas. He collected in Chiapas, often for extensive periods, every year between 1964 and 1992 (except for 1969 and 1990). These collections were made during a time when much of the original vegetation of that state was still intact. They document one of Mexico's most diverse floral assemblages and provide a legacy for future generations to study and admire. The first set of Breedlove's collections is deposited at the Academy (with the earlier-collected specimens in DS and the later-collected ones in CAS) and duplicates are widely distributed among herbaria. He personally maintains his field notebooks. *Breedlovea*, a genus of Chiapan mosses, was described by the eminent bryologist Howard Crum in his honor.

While retaining his faculty position at Stanford University, John H. Thomas (1928–1999;

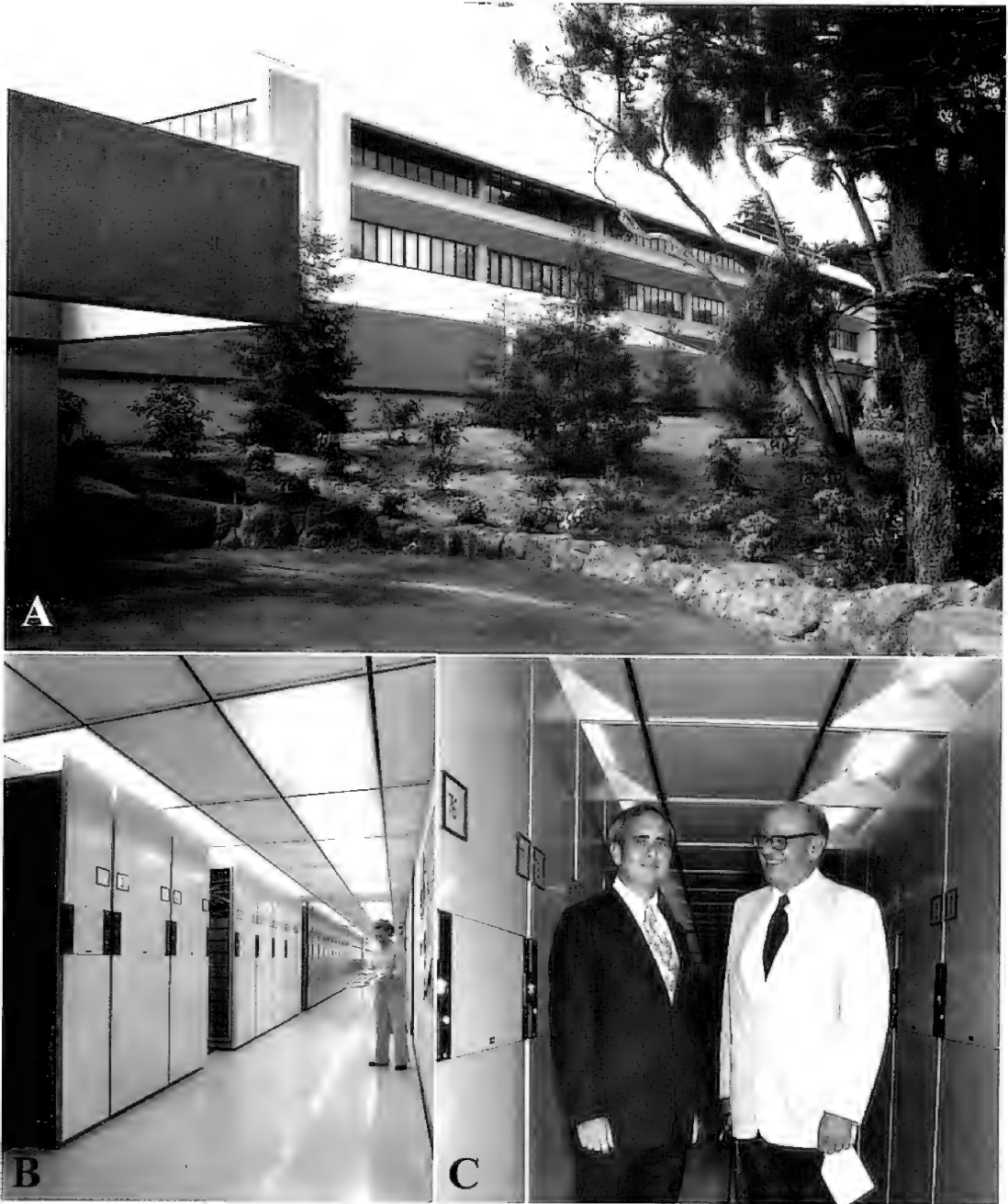


FIGURE 25. Department of Botany facilities in Golden Gate Park (1975–2003) A. Wattis Hall with the Department of Botany located on the third floor (1976 photo by L. Ullberg, CAS Special Collections). B. Compactorized storage of herbarium in Wattis Hall with E. McClintock (1976 photo by L. Ullberg, CAS Special Collections). C. Academy director George Lindsay (right) and departmental associate Peter Raven (left) during dedication ceremony of new botany quarters in Wattis Hall (1976 photo by L. Ullberg, CAS Special Collections).

Fig. 24B) spent one or more days a week at the Academy in his part-time curatorial position there. At Stanford, Thomas had been a doctoral student of Ira Wiggins,¹¹³ professor of biological sciences, and director of Stanford's Dudley Herbarium.¹¹⁴ His major botanical efforts include a floristic study of the Santa Cruz Mountains (based on his doctoral dissertation) that resulted in a popular and useful guide to the vascular plants along the coast of central California from Watsonville to San Francisco (Thomas 1961b) and, with Wiggins, a flora of the Alaskan Arctic slope (Wiggins and Thomas 1962). He was also interested in the history of botanical exploration in western North America and wrote an informative guide thereon (Thomas 1969).

Thomas began collecting plants in 1949 and made more than 20,000 collections from Alaska, Baja California (especially the Cape Region), California (especially the west-central portion of the state), and Montana (primarily the western portion of the state; Thomas in litt. 1981, Department of Botany "biography files"). His specimens are deposited in the Dudley Herbarium (DS) with duplicates dispersed to various herbaria (e.g., CAS and RSA). Shortly before his death, his personal herbarium at Stanford (to which reference was made in Thomas 1961a), consisting of several thousand duplicate specimens, was inspected and found to be so devastated by insect damage that it was discarded. His field notebooks remain at Stanford University.

To facilitate the integration of Stanford's Dudley Herbarium with that of the Academy, Alva G. Day (b. 1920; Fig. 24D), was hired at the Academy in 1975 as senior scientific assistant (subsequently assistant curator). Her position was initially funded by grants from the National Science Foundation. Day was born in Hollister, California and following training at the University of California, Davis and Oregon State College, received an A.B. degree in botany at the University of California, Berkeley. After stints as an herbarium botanist at UC-Berkeley and a research assistant in cytology at the Rancho Santa Ana Botanic Garden, Day completed her doctoral studies on *Gilia* (Polemoniaceae) at the Garden and received a Ph.D. from "Claremont University College" in 1964.¹¹⁵ She continued her research in cytogenetics and systematics at UC-Davis and UC-Santa Cruz prior to coming to the Academy in 1975. Transfer of the Dudley Herbarium to the Academy in 1976 was made possible, in part, by a five-year grant from the National Science Foundation. The task of integrating the two large herbaria continued for about 10 years with additional support from the National Science Foundation. When her NSF support ended in 1979, the Academy incorporated Day's position into the Department and she became an associate curator. As such, she continued the integration process and her systematic studies of Polemoniaceae until retiring in 1985. Following four years in the Washington, D.C. area, where she continued her studies at the Smithsonian Institution, Day returned to the Bay Area in 1989. She was made a research associate, and in 2002 she was appointed curator emeritus, in the Academy's Department of Botany where she actively studied Polemoniaceae (especially *Gilia*, *Allophyllum*, *Navarretia*, and *Loeselia*). Day's collections are primarily at either CAS or RSA, and her extant field notes and files are deposited at the Academy.¹¹⁶

With the amalgamation of the two herbaria, the Academy's collection of algae was transferred to the University of California, Berkeley, and most of the fungal collection was transferred to the United States Department of Agriculture in Beltsville, Maryland.¹¹⁷ Despite the lack of an institutional collection of algae, Sylvia Earle (b. 1935; Fig. 26A) was hired in the Department as a half-time curator of phycology in 1976. Earle is a prominent marine scientist with a doctorate (1966) from Duke University. Her interests include marine plants and animals, oceanography, and deep oceanic exploration. While at the Academy, her efforts were devoted primarily to lecturing and writing in conjunction with her interests in marine conservation. She collected algae but did not otherwise play an active role in the operations or activities of the Department of Botany. Her position became quarter-time and eventually honorary; it was discontinued by 1986. Algal collections



FIGURE 26. Academy botanists. A. Sylvia Earle (1983 photo by S. Middleton, CAS Special Collections). B. Bruce Bartholomew (1992 photo by C. Kopp, CAS Special Collections). C. George Lindsay (1994 photo by S. Middleton, CAS Special Collections). D. Heritiana Ranarivelo at Academy facility in Antananarivo, Madagascar (2003 photo by T. Daniel, Dept. Botany "biography files").

made during her tenure were eventually deposited at the herbarium of the University of California, Berkeley (P. Silva, pers. comm.).

In 1978, Frank Almeda Jr. (b. 1946; Fig. 27A) was hired by the Academy to fill the position vacated by McClintock. Almeda was born and grew up in Tampa where he learned many of the native and exotic plants of Florida. He received a B.A. from the University of South Florida in 1968. Immediately following receipt of a Ph.D. from Duke University in 1975, Almeda was appointed assistant professor in the Department of Biology at the University of California, Los

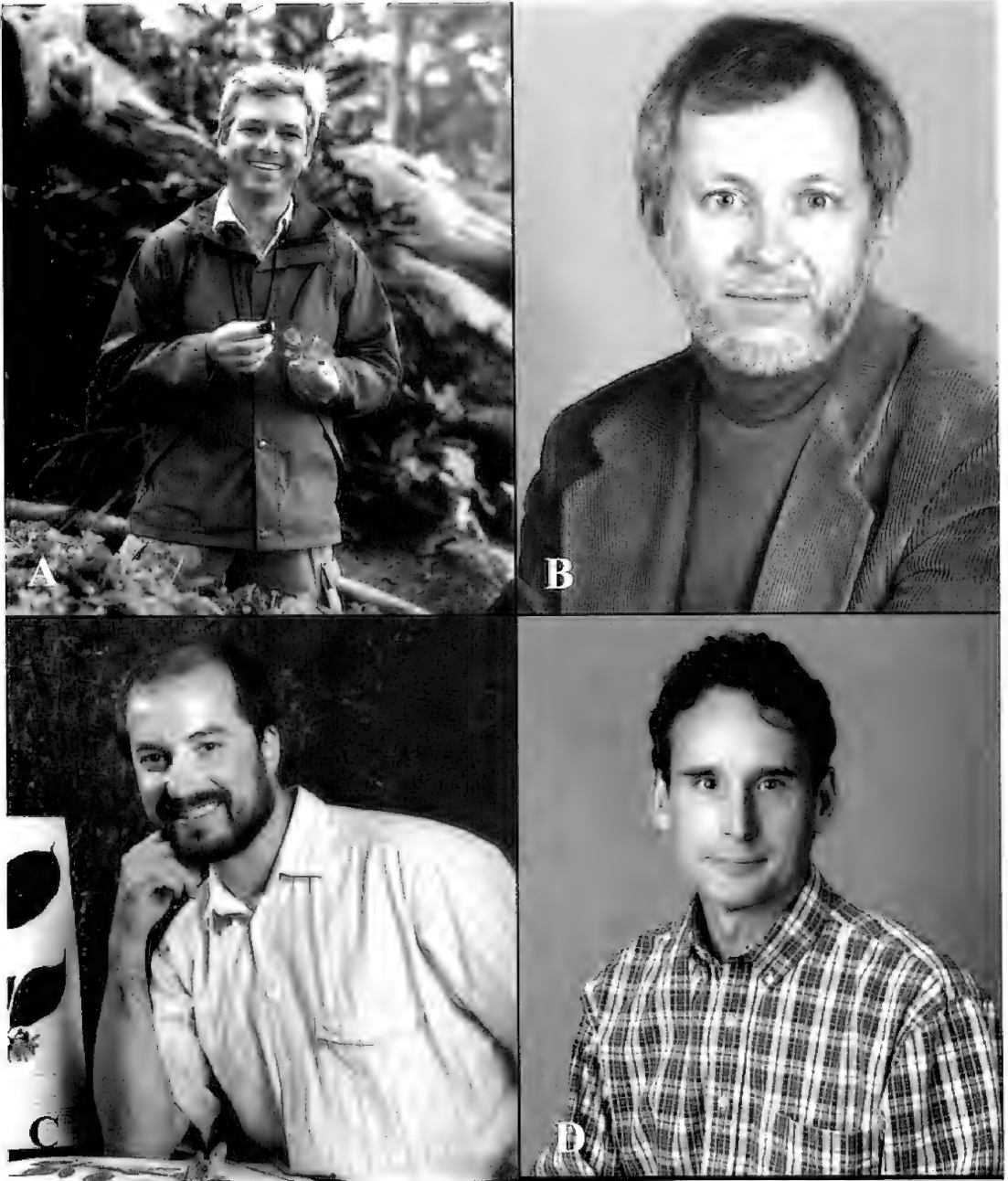


FIGURE 27. Curators of Botany in 2003. A. Frank Almeda (1992 photo by C. Kopp, CAS Special Collections). B. Thomas F. Daniel (1996 photo by D. Lin, CAS Special Collections). C. Peter W. Fritsch (1997 photo by D. Lin, CAS Special Collections). D. Kim E. Steiner (2000 photo by D. Lin, CAS Special Collections).

Angeles. There, in addition to his teaching duties, he was director of both the UCLA herbarium and the Mildred Mathias Botanical Garden. He brought a positive vigor to the botanical program at the Academy, collected with Breedlove in Mexico and Guatemala, undertook a revision of Howell's *Marin Flora*, and was instrumental in establishing departmental initiatives in Costa Rica and Madagascar. In 1981, Almeda was appointed to the first fully endowed curatorial position in the Department, the Decker and Martha McAllister Chair of Botany. Between 1983 and 1986, he served as the Academy's director of research. Although his knowledge of plants is extensive and global in scope, the subject of Almeda's dissertation and most of his subsequent publications has been the family Melastomataceae. His diverse studies of this large, mostly tropical family have been concentrated in Mexico, Central America, Brazil, and Madagascar.

By 1980, it was recognized that professional staffing in collections management was needed for operating the large and growing plant collection and to allow the curatorial staff sufficient time to concentrate on research.¹¹⁸ In 1982, Bruce Bartholomew (b. 1946; Fig. 26B) was hired to fill the newly created position of collections manager in the Department.¹¹⁹ Bartholomew was born in Boston, Massachusetts, grew up in southern California, and received a Ph.D. from Stanford in 1972. Prior to coming to the Academy, he had been employed as a botanist at the University of California Botanical Garden in Berkeley since 1973. Many of his publications deal with the Theaceae (especially *Camellia*). He initiated a collecting program in California's botanically least-known county (Modoc County) in 1988, and is preparing an account of the plants there. His interests in Chinese botany have resulted in numerous collecting trips to China, establishment of relationships with several Chinese herbaria, a position on the editorial committee of the *Flora of China*, and significant growth of the Asiatic collections in the herbarium.

In 1986, Thomas F. Daniel (b. 1954; Fig. 27B) joined the Department of Botany, filling the position previously occupied by Day. Daniel was born in Durham, North Carolina, and studied botany at Duke University, from which he received an A.B. in 1975. He received a Ph.D. from the University of Michigan in 1980 and, following a semester as lecturer at Michigan, took up a position as curator of the herbarium at Arizona State University in 1981. At Arizona State, his duties consisted of research and curation. There he continued studies of New World Acanthaceae that had been the subject of his doctoral research, and began several floristic projects in Arizona.¹²⁰ After coming to the Academy, Daniel expanded his interest in Acanthaceae to the Paleotropics, began a floristic account of the plants of San Francisco County based on Howell et al.'s *A Flora of San Francisco, California*, and took over editing of *Flora of Chiapas* (which had been begun by Breedlove). Daniel served as editor of scientific publications at the Academy from 1991 to 1994. His collections are primarily from Arizona, California, Mexico, Central America, Bolivia, and Madagascar with first sets at MICH, ASU, and CAS.

In 1996, Peter W. Fritsch (Fig. 27C) was hired to fill the position vacated by Breedlove. Fritsch was born in Milwaukee, Wisconsin in 1961, received both B.S. and M.S. degrees at the University of Michigan, and in 1995 was awarded a Ph.D. from Claremont Graduate School for his studies on *Styrax* (Styracaceae) at the Rancho Santa Ana Botanic Garden. He was a Mellon Postdoctoral Fellow in Botany at Duke University prior to coming to the Academy. His studies of phylogeny and biogeography in *Styrax* and other woody genera involve the use of molecular data; indeed, Fritsch was the first botanist hired at the Academy with a background in the techniques of molecular systematics. At the Academy, he has spearheaded the interdisciplinary biotic survey of the Gaoligongshan biodiversity hotspot in western Yunnan, China. His collections are largely from Michigan, the West Indies, Mexico, Madagascar, and China.

Although he was never a member of the Department of Botany's staff, botanist George E. Lindsay (1916–2002; Fig. 26C) was in important figure in overseeing growth of the Academy, in

shaping the staffing and facilities of its research departments, and publishing the results of his research on cacti. Lindsay was born in Pomona, California and worked for a period as a citrus farmer on a lemon farm he had inherited. He received both his undergraduate and graduate degrees at Stanford University. His doctoral work on *Ferocactus* (Cactaceae) under Ira Wiggins was eventually published (Lindsay 1996) by his friends and admirers.¹²¹ As executive director of the Academy from 1963 until 1982, and thereafter as director emeritus, Lindsay pursued his interests in systematics of *Ferocactus*, development of the Academy's nature preserve (Pepperwood) in Sonoma County, and natural history/conservation in the peninsula of Baja California and the Galapagos Islands. He maintained an office in the Department of Botany from his retirement as executive director until a few years prior to his death. In 1998, the Lakeside Foundation established an endowed chair in the Department of Botany in honor of George and Geraldine Lindsay.

The creation of this new position in the Department led to the hiring of Kim E. Steiner (b. 1953; Fig. 27D) in 2000 as the first George and Geraldine Lindsay Chair of Botany. Steiner was born in Ann Arbor, Michigan, received an A.B. degree from Indiana University, and was awarded both M.S. and Ph.D. degrees from the University of California, Davis. Following his doctoral studies on pollination of Neotropical Euphorbiaceae, Steiner was a scientist with the National Botanical Institute of South Africa and was stationed at the Compton Herbarium in the Kirstenbosch Botanical Garden. There, he pursued his interests in pollination biology and systematics of Scrophulariaceae and Orchidaceae in the rich flora of the Cape Region. His research, combining information on breeding systems with molecular phylogenetics, added another dimension to the subdisciplines represented in the Department. Most of his collections are from southern Africa, Andean South America, Panama, and Mexico.

Several significant events or activities in recent years have also contributed to expanding the influence, outreach, and reputation of the Department of Botany. In 1982, the Tilton Postdoctoral Fellowship in systematics was established at the Academy.¹²² The first recipient of this year-long fellowship was botanist Leslie R. Landrum who studied Myrtaceae in the Department during 1983–1984. In 1995–1996, Panamanian botanist Ivan Valdespino held the Tilton Fellowship. He studied *Selaginella* during his tenure at the Academy.

In 1998, Academy curators were invited to become research professors in the Department of Biology at San Francisco State University. This permitted curators to chair graduate student committees at SFSU and to have their graduate students work at the Academy. The first graduate student in the Department of Botany participating in this joint Academy-SFSU program was Geoff Smick, who began his studies in 2000.¹²³ Numerous undergraduate students have worked with the current curators in the Department of Botany, either under the auspices of the Academy's Summer Systematics Institute, the Academy Fellows Illustration Internship, Wallace Internship, the Cooley Internship, or independently.¹²⁴

Using some of the earnings on the Department's endowed funds,¹²⁵ Academy botanists decided in 2001 to employ a plant collector in Madagascar. With assistance from the Missouri Botanical Garden, a young Malagasy botanist was identified, brought to San Francisco for discussions, and hired in 2002. Heritiana Ranarivelo (b. 1975; Fig. 26D) is stationed at the Academy's research facility in the Malagasy capital, Antananarivo. He received a Diplôme d'Etude Approfondie in plant biology and ecology from the University of Antananarivo in 1999. As the Department's botanical coordinator for projects in Madagascar, he collects, processes, and identifies plants; works closely with various governmental agencies and private organizations that seek to promulgate and preserve the Malagasy flora; assists Academy botanical expeditions to Madagascar; and collaborates with Academy scientists on their research in the country.

During the 1980s and 1990s curation of and studies on the remaining cryptogamic collections

at the Academy (bryophytes and lichens) were reinvigorated. These efforts were overseen by senior curatorial assistant Mona Bourell (b. 1952), who had studied bryophytes at San Francisco State University. She actively curated, added to, and promoted use of the bryological collection. In 1996, Department associate James Shevock shifted his research focus from vascular plants to bryophytes and began adding to that collection as well.¹²⁶ Volunteers from the California Lichen Society were active for a period in the 1990s working with the lichen collection.

As of 2003, the Academy's Department of Botany consisted of 12 Academy-funded staff members (4 curators, 1 collections manager, 1 botanical coordinator in Madagascar, 5 curatorial assistants, and a secretary/receptionist).¹²⁷ Others working in the Department at that time included Orbelia Robinson, editorial assistant for the Flora of China Project (funded through the Missouri Botanical Garden), and Lihua Zhou, botanical project manager for the Academy's biotic survey in western Yunnan, China (funded by the National Science Foundation). In addition to salaried staff, the Department has benefited greatly by a dedicated corps of volunteers from the local community.¹²⁸ Current volunteers assist in numerous departmental activities including: specimen preparation, library work, label preparation, plant identification, and assistance with research projects.

Also as of 2003, the Department's herbarium (comprising both CAS and DS) contained 1,824,000 total specimens with an average annual accession rate since 1990 of about 20,000 specimens.¹²⁹ The vascular plant collection is worldwide in scope with 1,771,500 specimens including 10,555 types. The collection includes approximately 50,000 pteridophytes, approximately 15,000 gymnosperms, and approximately 1,706,500 flowering plants. The bryophyte collection numbers about 39,500 specimens and is worldwide in scope. The lichen collection contains about 13,000 specimens and is also worldwide in scope.¹³⁰ Databasing of the entire collection of plants from Chiapas, Mexico (which numbers more than 56,000, and upon which the *Flora of Chiapas* is largely based) has been completed. Databases of both the Chiapas and type collections are available electronically on the Department's web page at: <<http://www.calacademy.org/research/botany/>>. Other databases and information about the Department are also available at that URL. The Lillian Devendorf Hohfeld Botany Library¹³¹ houses approximately 560 botanical periodicals (i.e., entire journal runs or portions thereof), more than 13,700 botanical books/monographs (not individual titles, but non-journal barcoded items), and three reprint collections.¹³²

VI. IMPLICATIONS, IMPACTS, AND FUTURE DIRECTIONS

Amateurs in Botany

In relating the major historical events concerning botany and botanists associated with the California Academy of Sciences during its first 150 years several themes and threads are evident and worthy of some discussion. Prominent among these is the role of amateurs in plant sciences at the institution. Much of the history of botanists at the Academy is dominated by interested and capable amateurs (i.e., those pursuing botany as an avocation, often without benefit of extensive formal schooling in the science). Like many early botanists affiliated with the Academy, Kellogg and Curran/K. Brandegee were both medical doctors;¹³³ Greene was a minister; and Eastwood (whose highest educational degree was a high school diploma) had been a schoolteacher. Howell was the first professional botanist hired at the institution, and McClintock (who became a curator in 1949) was the first Academy botanist to earn a Ph.D.

The proactive encouragement of amateurs in the botanical work of the Academy was raised to a new level with the establishment of the California Botanical Club in 1891. Under the successive leadership of Brandegee, Eastwood, and Howell, its members assisted in or conducted botanical

research and they provided technical labor, funds, and collections to augment the operations of the Academy's often underfunded Department of Botany. Eastwood, Howell, and McClintock all helped to bring botany to a general audience by publishing popular articles in a variety of outlets. It is perhaps revealing of Howell's nature that he, the first professionally trained botanist hired by the institution, probably did more to encourage and train avocational botanists than any other Academy scientist. Results of his efforts are manifest by the local floristic treatments noted above.

Female Curators and Gender Discrimination

Much has been made of Kellogg's resolution of 1853 to admit females into all aspects of Academy life. The fact that the hiring of female curators there began in the 1880s is particularly remarkable. In spite of its early declaration and subsequent actions in hiring women, was gender discrimination present at the Academy? Undoubtedly it was to some degree, just as it was widespread in public and private organizations in the United States prior to legislation and litigation that made discrimination based on gender unlawful. Kellogg was always referred to as "Dr. Kellogg" by Hittell (1997) whereas Katharine Curran Brandegee (also an M.D.) was always referred to as either "Mrs. Brandegee" or "Mrs. Curran". However, this is also how she was referred to in *Zoe*, a journal over which she exercised considerable influence. Several men served with her as "co-curators" before she became the sole curator of botany. Following Brandegee's departure, Eastwood also was a "co-curator" with various men for a number of years. Upon Howell's retirement, McClintock was made "acting chairman" for several years before she was accorded the title of "chairman." One can only guess as to the extent these "perceived slights" actually represented gender discrimination. Compared with many other academic institutions, however, the Academy's record on employment opportunities for women can only be regarded as enlightened. Indeed, that record is a monumental testament to the men who hired and worked with these early female curators, to the female curators who unfailingly proved their abilities time and time again, and to the institution that conducted this "experiment in equality" in the nineteenth century. It is to be hoped that in the coming years, the institution will carry this experiment even further with the proactive training and hiring of other underrepresented minorities in the natural sciences.

Responses of female curators of botany at the Academy to gender discrimination, real and/or perceived, is of interest. Bonta (1991) portrayed K. Brandegee, undoubtedly with ample justification, as a woman who was much maligned in her profession because of her gender, and who was rather self-deprecating and defensive (if not bitter) about her professional status. McClintock exhibited a similar attitude based on both her gender and chosen field of study, horticultural taxonomy (see Regional Oral History Office 1987). Brandegee's professional successes at the Academy likely helped to make Eastwood's pursuing a career in botany there less difficult. But the divergent personalities of these two strong-willed individuals probably contributed more to their respective successes and failures than did discrimination by the male-dominated scientific establishment. In spite of her meager formal education, Eastwood was outwardly self-confident, optimistic, and determined to accomplish her goals irrespective of any obstacles. Given the ordeals that she experienced as a child, and the privations and dangers she faced while collecting plants in the Colorado Rockies as a young woman, the opportunity to work in and contribute to her beloved profession of systematic botany was surely the joy of which she so often spoke. It was unlikely that she would be prevented from her tasks by anyone—male or female. It was indeed fortunate for both the discipline of botany and for the Academy that she was a curator during and following the Great San Francisco Earthquake and Fire.

Destruction and Opportunity

Undoubtedly, the most significant event of the first 150 years of the Academy's history was the destruction of its buildings, collections, and records by the earthquake and fire of 1906. The loss of almost all botanical collections, manuscripts, and library materials was a tremendous setback, not only for the institution, but for plant science in California as well. Yet that event also provided a turning point for the development of botanical resources at the Academy. Indeed, the deleterious effects were partially ameliorated by subsequent actions taken—some inherent in how botany functions as a discipline and others both heroic and fortuitous. Key among these was Eastwood's rescue of the types that she had segregated from the Academy's herbarium. These not only provided some important collections from the otherwise destroyed herbarium and a focus for rebuilding the botanical collections at the institution, but those 1,497 specimens provided both a physical and a symbolic icon around which the Department (and the institution) could rally for years to come. The destruction itself sparked fieldwork by Eastwood (and later Howell) who sought to replace much of what had been lost through extensive collecting in California and elsewhere in the western United States. The abundant exchange materials (both plants and published literature) that had been sent around the world by Kellogg, Curran/Brandeggee, and Eastwood prior to the destruction had helped to disperse California's botanical resources and to draw attention to the small institution on the Pacific Coast of North America. Many recipients of these exchanges then provided donations of literature and specimens to help rebuild the Academy.¹³⁴ Through Eastwood's personal efforts, generous gifts of specimens and library materials, and selective purchases of important botanical specimens, the Department of Botany reestablished itself as a place of scientific prominence within a few decades of its 1916 reopening in Golden Gate Park.

Coincident with the rebuilding of botanical resources at the Academy came the beginning of a shift in focus in those resources. Although the Academy had accessioned plant collections from all parts of the world prior to 1906, it was primarily a provincial collection with a focus on the temperate flora of California and the western United States. By 1906 other herbaria concentrating on California's rich plant life were operating in the San Francisco Bay Area and were available to the botanical community (i.e., at the University of California in Berkeley and at Stanford University in Palo Alto). Following the destruction of the largest collection of plants from California, Eastwood sought to establish a worldwide collection in its place. Such a shift in focus is likely typical for many growing herbaria when they attain a sufficiency of resources involving collections, library materials, and staff. Eastwood sought to augment the focus of the collection in the absence of such resources, however. Two events helped her to achieve this goal very quickly. The first was Alban Stewarts's (Fig. 20) vast plant collection from the Academy's 1905–1906 expedition to the Galapagos Islands. These arrived in San Francisco following the earthquake and fire and would become a unique tropical resource at the institution. Purchase of the large Prager herbarium in 1920, with specimens from many parts of the world, also exemplified this shift to an internationally focused collection at the Academy. These acquisitions were subsequently augmented by Howell's extensive collections from the Galapagos Islands and other localities in the eastern Pacific region during the Academy's Templeton-Crocker expedition, and by Lewis Rose's personally funded, worldwide exchange program on behalf of the Department of Botany. The shift to a worldwide herbarium culminated with the hiring of Breedlove in 1969. Combining Breedlove's interests in the flora of southern Mexico, his prodigious collecting abilities,¹³⁵ and the diverse collection established by his predecessors, an environment ripe for the study of tropical plants had been created at the institution. Given the research priorities in systematic botany and available extra-mural funding at that time (e.g., Buechner and Fosberg 1967; Sohmer 1980; Raven 1988) this was a fortuitous circum-

stance. The Department's commitment to enhance botanical knowledge of the entire planet (especially tropical regions) has been reflected in all subsequent curatorial hires since that of Breedlove. With this increased international perspective, the Department of Botany has continued to address local and regional botanical needs. The production or revision of local floras has continued without interruption in the Department since Howell's retirement. Indeed, the Academy now seeks to provide new insights into the taxonomy of western American plants by supporting a position dedicated to Californian and western North American botany via the endowed Howell Chair. The Academy's herbarium once again houses the largest collection of California's vascular plants; and now these plants can be studied at the institution in the context of the entire planet's flora. Eastwood had the foresight, set the stage, and provided the initial resources; it is little wonder that her vision has been realized.

In spite of all that has been achieved since the destruction of 1906, it is important to note that rebuilding the botanical resources at the Academy has been a lengthy process. Where possible, reacquisition of duplicates of the lost treasures, with respect to both plant collections and botanical literature, continues to the present day. For example, in 1960 Academy director Miller (1960) noted that the Department had reacquired a set of C.G. Pringle's Mexican collections.¹³⁶ A previous set of Pringle's important collections had been destroyed at the Academy in 1906 and many of the species they encompassed had not been represented in the collection since that time. The largest reacquisition of early California plant specimens, including many that had been represented at the Academy in 1906, came about with the incorporation of Stanford's Dudley Herbarium into that of the Academy. Because the Academy had exchanged specimens with Stanford University, some specimens collected by Academy botanists (including Kellogg and Bolander), that were destroyed at CAS in 1906 are now represented at the institution by duplicate specimens that are part of the Dudley Herbarium. These bear the "DS" rather than "CAS" accession.¹³⁷

Importance of Early Curators

Founders of the Academy were described by Jepson (1897) as men who devoted themselves to the institution's "scientific upbuilding" with a manifest "single-heartedness." The early history of botany at the Academy also reflects this type of devotion among the individuals elected or hired to curatorships at the institution. Whether mild-mannered (e.g., Kellogg) or strong-willed (e.g., Curran/K. Brandegee), they were generous "workaholics" who often put the Department's interests and welfare above their own. Their lives were devoted primarily to their studies and to the Academy. Indeed, until the 1960s most of the long-term curators of botany at the Academy (except Brandegee) remained unmarried.¹³⁸

It is undoubtedly revealing of the early Academy that those who were to become its most famous botanists consisted of a failed mid-nineteenth century physician/pharmacist who believed in equal employment opportunities for women, an unsuccessful female physician who was apparently the first woman hired in a senior curatorial position at a major museum, an aspiring science writer and self-taught botanist whose highest educational degree was a high school diploma, and a recently-fired professional botanist with a Master's degree. Each of them, Kellogg, Curran/K. Brandegee, Eastwood, and Howell, became prominent and respected botanists whose impact and influence continue to the present day. They brought honor, respectability, and fame to the California Academy of Sciences, and they established high standards and visionary goals to which their successors have aspired. The words applied to Kellogg by his good friend George Davidson (1889:vi) are indicative of this type of person, and would appear to be equally applicable to most of his well-known successors: "He had a cheering word for every effort, he assisted each young

aspirant, he gave his time lavishly to investigation and to that diffusion of knowledge which is for the betterment of the people." They created an atmosphere that was inclusive and conducive to productive botanical research. The spirit present in the little gallery of the church building that harbored the Pacific Coast's leading botanical center for much of the last quarter of the nineteenth century was well remembered by S.B. Parish¹³⁹ many years later when he reflected upon "the kindly generous spirit which they show to visitors, throwing open their herbarium and their library and assisting them in every way that they can..." (Anonymous 1922:73).

The generosity and hospitality of the early curators has been a recurrent theme throughout the history of the Academy's botanical program. In spite of differences in personality and belief, botanists at the Academy generally have gotten along well with one another and provided an atmosphere conducive to their work as well as to that of the amateurs and professionals that sought their assistance. This was particularly evident during the tenures of Eastwood and Howell. Indeed, it is worth relating the stories of three significant workers in the Department of Botany who were welcomed and nurtured at different stages of their lives by both curators.

Lewis S. Rose (1893–1973, née L.S. Rosenbaum; Fig. 28A–B) was a native San Franciscan whose initial association with the Department of Botany at the Academy dates from 1915 when he began accompanying the Botany Club on field trips with Eastwood. He received an undergraduate degree in botany at the University of California, Berkeley in 1917. After service in World War I, he worked in the investments field and became financially independent. In 1930 Rose volunteered his botanical talents to the Academy's herbarium; he subsequently became both an Academy fellow and a research associate in the Department of Botany. Rose worked four days a week in the Department as a volunteer for more than 30 years. He was responsible for much curatorial work including filing specimens in the herbarium, collecting plants, preparing exchanges, and maintaining bibliographic files. At his own expense, Rose collected plants (mostly in California and often with the Botany Club) that he exchanged with foreign and domestic herbaria. During the next 30+ years, Rose's exchange activities resulted in the receipt of between 70,000 and 100,000 specimens, all of which were donated to the Academy. Rose's personal collections resulted in the discovery of several new species (at least 10 of which bear his name), and his exchange materials have enriched the Academy's herbarium with plants from around the world. Following his death, his widow, Elise, created the Lewis S. Rose Memorial Fund in the Department of Botany. After her death, the couple's son, John J. Rose continued to add to this fund, which became the Lewis and Elise Rose Memorial Fund.¹⁴⁰ In 2000, John Rose established the John J. Rose Postdoctoral Fellowship in Botany at the Academy with a sizeable donation.

Following his retirement from the United States Department of Agriculture in 1944, Dr. Thomas H. Kearney (1874–1956; Fig. 28C) came to San Francisco where his two sisters had settled. Kearney was born in Cincinnati, Ohio and was educated at the University of Tennessee and Columbia University. He had been a botanist with the Department of Agriculture since 1894 and retired from the Bureau of Plant Industry where he was principal plant physiologist. He was an expert on cotton breeding and conducted many of his studies in Arizona. While there, he became interested in the state's native plants, which he collected in his spare time. This avocational interest resulted in the publication in 1942 of *Flowering Plants and Ferns of Arizona*, co-authored with his colleague Robert H. Peebles (Kearney and Peebles 1942). Once in San Francisco, the distinguished cotton breeder and expert on Arizona's flora was invited by Eastwood to continue his work at the Academy. Kearney was given the title of research associate in the Department of Botany and subsequently was named an honorary curator. At the Academy, Kearney (in collaboration with Peebles) prepared a revised and expanded account of Arizona's plant life, *Arizona Flora* (Kearney et al. 1951) and continued publishing his taxonomic studies on the cotton family (Malvaceae). In

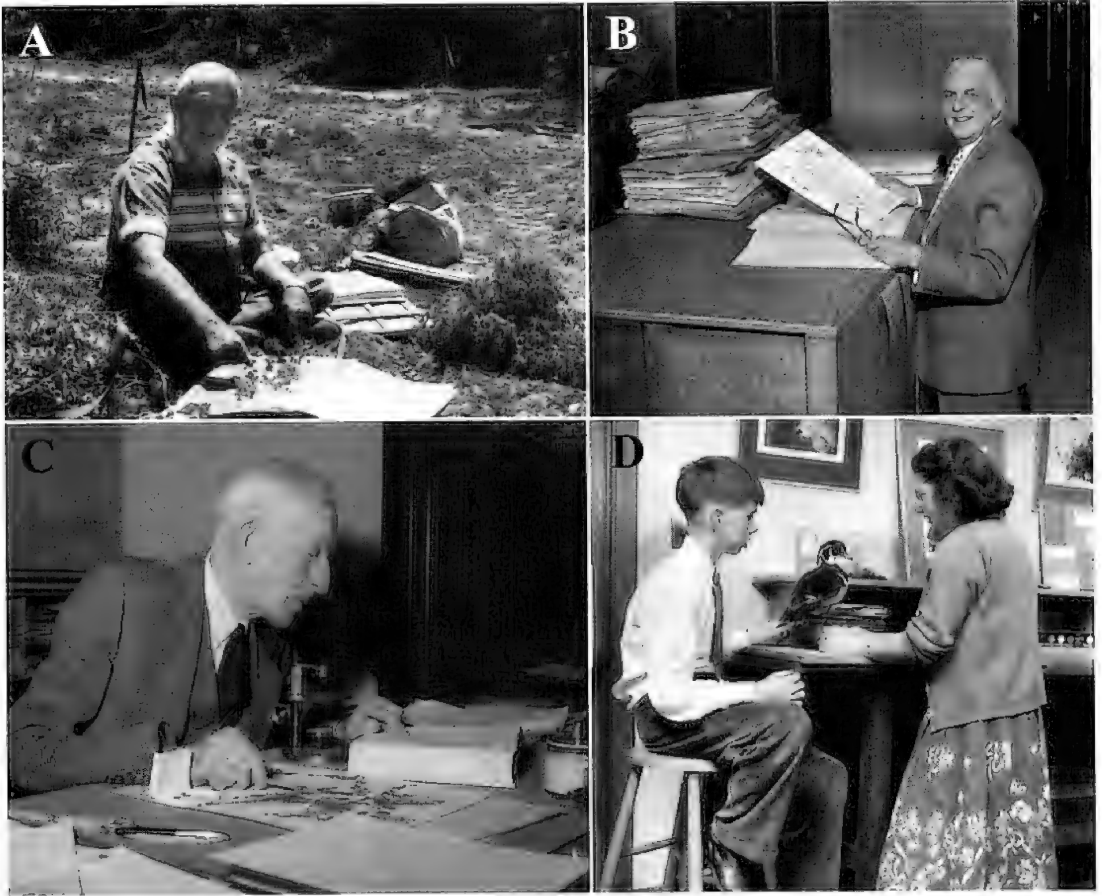


FIGURE 28. Departmental associates. A. Lewis S. Rose collecting in Ben Lomond sandhills, Santa Cruz Co., California (1962 photo by J.T. Howell, Dept. Botany "biography files"). B. Rose in herbarium (1962 photo, CAS Special Collections). C. Thomas H. Kearney using Eastwood's lens in herbarium (ca. 1952 photo, Dept. Botany "biography files;" used in *Pacific Discovery* 5(2):529, 1952). D. Peter Raven and Student Section instructor Joan Taylor (ca. 1950 photo, CAS Special Collections).

posthumous reminiscences, Kearney (1958:280) noted that he had accepted Eastwood's invitation to make his headquarters at the Academy "with alacrity and have never regretted doing so. I have found working conditions there very satisfactory and the personal associations most congenial." Kearney's friendship and contributions were also much appreciated by his Academy colleagues: Wiggins (1952) published a biography of him in the institution's magazine, and Howell's *Leaflets of Western Botany* volume 8(12) consisted of a tribute to him.

Nine year old Peter H. Raven (b. 1936; Fig. 28D) first visited the Academy's Student Section (subsequently Junior Academy) in 1945. Although he was initially primarily interested in collecting and identifying insects, Raven had general interests in natural history. "My first contact with the Botany Department came while on a Student Section tour of the departments. In botany I found that marvelous lady who had been associated with the Academy for so many years, the late Miss Alice Eastwood. When I first met her in 1946, she was near her ninetieth birthday, but she had lost none of her love for plants or helpfulness to those who studied them. I can remember Miss Eastwood looking through a small collection of plants I had made in the Santa Cruz Mountains, stopping here and there while naming them to give me a word of encouragement. I recall her saying as

she examined a collection of a small wood-rose, for example, 'How happy I am that you collected it with fruit. Now it is really quite simple to identify it — see, it has no hips.' Thus was Miss Eastwood able to teach picking the positive instead of negative aspects of any situation. One can imagine the effect of a compliment from Miss Eastwood to a young student" (Raven 1956:3). This encounter prompted Raven to collect more plants during the next few years and to bring them to the Department of Botany. "I well remember that a strange plant of the sunflower family which grows along streams in the hills (*Petasites palmatus*), was the first specimen that I was privileged to bring to the Botany Department myself. Here Mr. Howell, another master at the art of imparting his enthusiasm to all ages and types of students, told me what the plant was and a little about it" (Raven 1956:5). Between 1949 and 1956, Raven was employed part-time by the Department of Botany. Some of his work consisted of collecting plants for an account of the flora of San Francisco County, on which project he served as a co-author (Howell et al. 1958). Among his extensive and well-prepared collections from San Francisco were a new *Arctostaphylos* (*A. hookeri* subsp. *ravenii*) and a new *Clarkia* (*C. franciscana*).¹⁴¹

Raven's association with the Academy and its Department of Botany helped to determine his well-known career path in systematic botany, natural history, and conservation (Raven 1956; Carlquist 1997). Raven is a fellow of the Academy and an associate in the Department of Botany. Since 1971, he has been director of the Missouri Botanical Garden in St. Louis.

Kellogg's generosity and collegiality had attracted both interested individuals and much-needed collections to the young Academy. Katharine Brandegee's sponsorship of the California Botanical Club with its corps of willing apprentices, plant collectors, and herbarium volunteers continued the tradition. The nurturing of Rose, Kearney, and Raven by Eastwood and Howell, and the kindnesses shown to them while at the Academy, were repaid many times over by the collections, prestige, and friendship these three individuals, and many others like them, brought to the institution. In conjunction with the public exhibits in the Academy's natural history museum, the informal and personalized botanical instruction by the curators was primarily responsible for building a local botanical community and following.

Evolution of "Curator" and Changing Trends in Research

The Academy's founders had three basic objectives: development of the natural sciences largely through investigation of California's natural and cultural resources, assemblage and maintenance of museum collections, and establishment of a scientific library (Miller 1960). The role of carrying out this mission was and generally remains the responsibility of Academy curators. While the primary duties of botanical curators have remained stable throughout the institution's history (e.g., collecting specimens in the field, overseeing the herbarium, conducting original research, and determining most acquisitions for the library) the position of "curator" has undergone considerable evolution.

Early curators were elected annually and were not paid for their services to the institution. The title sometimes appears to have been rather honorific (as in the case of several nineteenth century curators who are not known to have contributed significantly to botanical activities at the institution). Early curators were essentially avocational scientists who lived off their personal wealth or who earned their living outside of the institution. There was a gradual transition to the university-trained, salaried, professional curators of today. Much of this change, from avocational to self-sustaining vocational curator, came about during Eastwood's tenure as curator of botany. Without the income she received from her property in Colorado, she might have found it much more difficult to make a living and undertake extensive field expeditions on her curator's salary early in her Acad-

emy career. By the time she retired, however, the institution was hiring Ph.D.-level curators to undertake careers as research scientists at the Academy. With the hiring in 1982 of a professional collections manager to supervise the Department's technical staff and collections, curators had more time to devote to their primary functions and to assume new duties (e.g., supervising students).

Research trends in the plant sciences toward increased specialization and away from field- and herbarium-oriented studies to those based primarily or partially on molecular data (e.g., Lammers 1999; Gropp 2003) are reflected by the research of Academy botanists. Early curators were botanical generalists: Kellogg and Brandegee worked on vascular plants, non-vascular plants, and fungi. Eastwood, Howell, McClintock, and Breedlove studied diverse vascular plant families. Current curators mostly specialize on a particular family (or small group of families) for their careers. The emphasis on floristic research that was critical to understanding California's unique biodiversity yielded (at least partly) to revisionary and monographic studies within a particular family based on morphological attributes. In recent years, phylogenetic analyses based primarily on molecular data have become either a component of monographic studies or the primary focus of investigations.

Relationships with other Centers of Botany in the Bay Area

Until the founding of the University of California in 1868, the history of resident institutional botany in California was the history of botany at the California Academy of Sciences. As other academic centers formed and grew in northern California, there were naturally periods of cooperation as well as times of personal and institutional rivalries. Fortunately, the former have far exceeded the latter in recent years. There have been professional botanical interactions between the Academy and most of the colleges and universities in the San Francisco Bay Area (especially with the University of California, Stanford University, and San Francisco State University). Behr taught classes at the University of California's medical school; Academy botanist Greene became the first professor of botany at the University of California, Berkeley; and Kellogg, Bolander, Harkness, and Gibbons had all offered botanical courses in Berkeley (Constance 1978). Some Stanford botanists have served as Academy curators (e.g., Dudley and Thomas). McClintock taught at San Francisco State for a brief period and the current curators all have academic appointments there. Academy-nurtured Raven became a third-generation graduate of Berkeley in 1957, then taught at Stanford, while maintaining strong linkages to the Academy, from 1962–1971. The well-documented rivalry between Greene and his former Academy colleague Curran/K. Brandegee was passed on, to some extent, to Greene's student and successor Jepson and Brandegee's protégé Eastwood. Eastwood had supporters in Berkeley, however, and she was generously offered working space there following destruction of the Academy's herbarium. Botanists from both the University of California and Stanford University have participated in numerous Academy expeditions. Prominent botanists from nearby universities have served on the Academy's Board of Trustees (e.g., Lincoln Constance from the University of California and Ira Wiggins from Stanford University, both of whom served as President of the Academy) and many local botanists have been elected Academy fellows.¹⁴²

Because the collections at the Academy and those at the University of California, Berkeley and San Francisco State University¹⁴³ are largely complimentary rather than duplicative, it remains in the best interests of systematic and evolutionary botany that botanists at these institutions continue to cooperate, provide mutual support, and direct the growth of their respective herbaria in unique directions. In this way, a comprehensive and multi-institutional botanical resource, based on both public and private funding, is maintained in the San Francisco Bay Area.

Research Results

For 150 years, the focus of botanical activities at the Academy would be determined by the specific interests of its botanical curators. Research activities of the curators have emphasized systematic studies based on fieldwork and herbarium investigations, i.e., collections-based organismal botany. Because California's plant life was largely unknown at the middle of the nineteenth century when the Academy was founded, it is not surprising that for the remainder of that century and for much of the next, Academy botanists concentrated their efforts on documenting and describing the state's flora.

As the flora of California became better known, the research interests of Academy curators spread to other parts of the world. Major Academy expeditions with a botanical component were summarized for the first hundred years of the institution by Munz (1953). These included a series of expeditions to Baja California beginning in 1888 with T. Brandegee often serving as the plant collector; the 1903 expedition of the schooner *Mary Sachs* along the west coast of Baja California and to the Revillagigedo Islands with botanical collector Frederick E. Barkelew; the 1905–06 expedition on the schooner *Academy* to the Galapagos Islands with botanist Alban Stewart (Fig. 20); the 1921 expedition to the Gulf of California on the schooner *Silver Gate* with botanist Ivan M. Johnston; the 1925 expedition to the Revillagigedo Islands and other islands and localities in western Mexico on the U.S.S. *Ortolan* with botanist Herbert L. Mason; and the 1932 Templeton-Crocker Expedition to the Galapagos Islands with botanist John T. Howell (Fig. 21C). A series of expeditions to the peninsula (and associated islands) of Baja California, Mexico, mostly under the auspices of the Belvedere Scientific Foundation¹⁴⁴ and including Academy personnel as well as botanists from Stanford University, the San Diego Natural History Museum, and the University of California, were undertaken from 1958 to 1972 (Lindsay 1983). These activities highlight long-standing and continuing interests by Academy botanists in the Galapagos Islands, the peninsula of Baja California, and islands off the west coast of Mexico.

Recent major botanical expeditions emanating from the Academy have gone even farther afield and include those to Madagascar in 1998 (with Academy botanists Almeda, Daniel, de Nevers, and Fritsch) and Yunnan, China in 1998–2003 (with Academy botanists Bartholomew, Bourell, Fritsch, Shevock, and Zhou).

Most publications emanating from scientists in the Department have been in the areas of floristics and monographic/revisionary taxonomy. Ornamental plants were of significant interest to Eastwood and were the major subjects of study for McClintock. In recent years, the use of molecular techniques (especially DNA sequence data) in addressing systematic and evolutionary questions about plants has become prevalent among the Department's botanists. Munz (1953) summarized the Academy's major contributions to botanical literature during its first hundred years. In addition to botanical publications, both by Academy scientists and others, in the institution's official serials (*Proceedings*, *Bulletin*, *Occasional Papers*, *Memoirs*), two privately-financed journals emanated from staff members (*Zoe* and *Leaflets of Western Botany*; Fig. 29) as discussed above. Since 1953, some of the major botanical contributions published by the Academy include: Almeda and Pringle (1988), Axelrod (1979), Dakin (1954), Daniel (1997), Gentry (1978), Lott (1993), McClintock (1957), McClintock et al. (1968), Moran (1996), and Walther (1972). The series of taxonomic accounts comprising the *Flora of Chiapas* is also an on-going departmental project with five parts (Introduction, Pteridophytes, Malvaceae, Acanthaceae, and Compositeae-Heliantheae s.l.) published between 1981 and 1999.

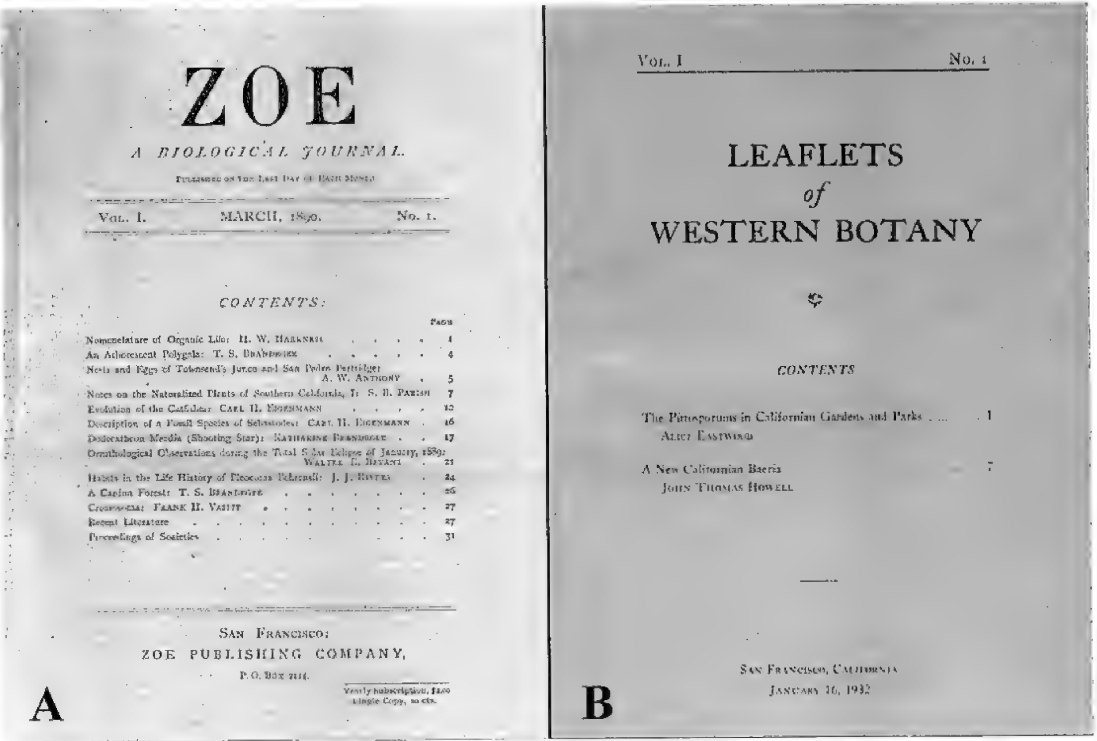


FIGURE 29. Private botanical journals emanating from the Department of Botany. A. *Zoe* (1890–1908), owned and largely edited by the Brandegees; the journal moved with them to San Diego. B. *Leaflets of Western Botany* (1932–1966), owned and edited by Eastwood and Howell.

Meeting the Challenge

From its earliest years the Academy has been what botanical historian Joseph Ewan characterized as a “Mecca” for naturalists on the Pacific Coast of North America. Indeed, it was and continues to serve as a major resource (via staff, plant collections, laboratories, and library) for both amateur plant enthusiasts and professional botanists. But by its sesquicentennial, the Academy had added another major dimension—that of a formal training center with proactive educational opportunities for both amateurs and professionals. New programs developed at the institution during the past 50 years include: docent training, adult and family education classes, workshops for science teachers, natural history tours, endowed internships, an undergraduate institute in systematics, and graduate assistantships for students pursuing advanced degrees at the Academy. All of these programs include a significant botanical component through the Department of Botany. Together, these programs seek to inform the public on biological issues and to help train the next generation of scientists.

Reflecting on the Academy’s first hundred years, Howell (1953:99) noted, “The growth of the present herbarium has been impressive,—from a few hundred specimens in 1906 to over 370,000 in 1953. But knowledge (*scientia*), not size, is the end for which we strive. Unless an herbarium serves as a basis for study and for published research, it is little more than a well-ordered hay-stack. In its first hundred years, the Academy herbarium has met and answered the challenge of the science it serves. In 1953, it enters upon its second hundred years with the expectation and hope that its scientific usefulness will be augmented and ever more fully realized.” Now, half way through

those second hundred years, I think Tom Howell would be very pleased with the myriad accomplishments of his successors at the Academy, the continued growth of the botanical collections, the new emphases on formal training, and the usefulness and relevance of the Department's resources to science, conservation, and humankind.

By the end of the twentieth century space limitations throughout the Academy and building restrictions imposed by the city of San Francisco forced the institution to reconsider its existing campus in Golden Gate Park. Plans to build a new facility at its existing site in the Park were deliberated upon and finalized by 2003. In order to demolish the existing campus of more than 10 buildings and rebuild an integrated facility in the Park, the institution relocated to a temporary site in downtown San Francisco in 2004. Completion of the Academy's new home in Golden Gate Park is slated for 2008. In conjunction with the move to temporary quarters, there was a reduction in the level of support staffing in the Department of Botany. The new facility in the Park will provide more space and new cabinetry for collections, climate controls for specimen preservation and pest management, and additional space for the various Academy and departmental initiatives (e.g., training students, projects in Madagascar and China). When relocated back to the Park, the Department of Botany also looks forward to restaffing at previous levels and adding an additional curatorial position (i.e., the John Thomas Howell Chair in Western American Botany). It is anticipated that, as in the past, future growth of the botanical collections will continue to be largely dictated by the interests of the Department's staff. Although relocation of the Department to interim quarters (with reduced staffing and space) presents challenges and frustrations, we know that we have a courageous and colorful past on which to draw, and we anticipate a bright future with new opportunities, systematic techniques, and personalities.¹⁴⁵

NOTES

¹ Some interesting observations/perspectives on what was and was not available in San Francisco at the time of the founding of the Academy were recorded by Charles B. Turrill in his 1918 Academy lecture, "The Early Days of the Academy" (an undated typescript of which is in the Academy's library). Turrill became a member of the Academy in 1870 and knew many of its early members (Leviton and Aldrich 1997).

² References to Hittell's manuscript are cited as "Hittell 1997"; references to footnotes and other information provided by the editors are cited as "Leviton and Aldrich 1997."

³ The institution was initially called the California Academy of Natural Sciences. "Natural" was dropped from the name in 1868 (Hittell 1997:95).

⁴ California had been under Spanish claim and rule from the 1540s until 1821 when Mexico became independent from Spain. Mexican California was ceded to the United States in 1848 following the U.S.-Mexican War of 1846–1848. It became the 31st state of the United States in 1850.

⁵ An account of this violent affair was given by Robert O'Brien in his column, "Riptides" in the *San Francisco Chronicle* of 2 May 1947, under the title, "The Scientist and the Gambler." In the early days of the nearly lawless coastal area of San Francisco, known as the "Barbary Coast," extralegal community groups or vigilantes formed to suppress civil disorder. Academy botanist H.G. Bloomer was active with the Committee of Vigilance (fide 5 April 1896 letter from H.R. Bloomer to W.L. Jepson in the H.G. Bloomer archives, C.A.S. Special Collections).

⁶ Early meetings of the Academy were described by one participant (Bosqui 1952:53) as, "sometimes more grotesque and amusing than scientific, and were not always harmonious; but on the whole were very interesting and instructive."

⁷ See McKelvey (1955) for a summary of Kellogg's alleged travels with John J. Audubon.

⁸ He was elected first vice-president in 1856, vice-president in 1870, librarian in 1867–1869, and director of the museum in 1875 (Hittell 1997). See Appendix 1 for the years he served as a curator.

⁹ Ewan (1953) noted that these collections were destroyed in a flood at Sacramento shortly after his arrival in California.

¹⁰ During its first years, the Academy's proceedings were published in such outlets as *The Pacific* and the *Daily Alta California*, both newspapers (Leviton and Aldrich 1997:33). See also note 28 below.

¹¹ The period from 1877 to 1884 was a time of financial and political instability at the institution during which no regular scientific series (i.e., *Proceedings*) was published. In 1884, the *Bulletin of the California Academy of Sciences* was issued, and its two volumes covered the years 1884–1887. In December of 1887, publication of the *Proceedings* (as "Second Series") was resumed (Brandegge 1893a; Leviton and Aldrich 1997; Ertter 2000).

¹² An annotated list of species proposed by Kellogg, and several other early Academy botanists, was published by Curran (1885). This number of species described by Kellogg appears reasonably accurate. In a conservative estimate of the number of species effectively published by Kellogg (i.e., excluding those proposed by Kellogg but effectively published by someone else) using The International Plant Names Index at <<http://www.ipni.org>> accessed on 31 December 2006, I counted 207 species.

¹³ Ertter (2000) provided an interesting discussion of the Academy's battle for scientific recognition (specifically with respect to priority of publication of new species by Academy scientists in Academy publications or local newspapers) from scientists in the eastern United States and Europe. See also Hittell (1997), Leviton and Aldrich (1997), and note 28 below.

¹⁴ Kellogg's decision not to bequeath his illustrations to the Academy is usually attributed to his opposition to the Harkness presidency at the institution in 1887 (see note 28 below). At the members' meeting of 17 December 1888, Hittell (1997:299), who was present, noted, "Dr. William P. Gibbons read a paper 'regarding the drawings of the late Dr. Albert Kellogg and his reasons for not leaving them to the Academy while the present administration was in power.' After a great many desultory remarks, it was, on motion, resolved that the paper was not in proper tone and should not be received by the Academy." For whatever reasons, Kellogg purposely chose not to leave his botanical drawings to the Academy. This is somewhat ironic because in 1856, Kellogg had supported a resolution that would have required the deposit at the Academy of all specimens or drawings on which publications emanating from the "departments of Zoology and Botany" were based (Hit-

tell 1997:48). Had that resolution passed, Kellogg's drawings would presumably have been deposited at the institution. It is also of interest that Kellogg and W.P. Gibbons had either maintained their friendship since their early days at the Academy or had reestablished it following Gibbons' involvement with the organization in the 1860s. Kellogg appears to have been largely responsible for Gibbons' removal from the office of corresponding secretary in 1855, which event led to Gibbons's lengthy disassociation from the Academy (Hittell 1997).

¹⁵ The first 44 pages of this work contain 24 of Kellogg's drawings accompanied by Greene's botanical text. The text and illustrations are preceded by former Academy president and Kellogg's Alaskan traveling companion from 1867, George Davidson's "Sketch of the life and work of Dr. Kellogg." Independent publication of this work at the instigation of several Academy members, was not without controversy at the Academy (e.g., see Hittell 1997:303).

¹⁶ See note 138 below for information on Parish.

¹⁷ No details were recorded by Hittell (1997) as to whether there was any dissension, or what discussion ensued.

¹⁸ Indeed, early curators at the institution drew their salaries from their professional lives outside of natural history.

¹⁹ Trask was not related to Blanche Trask (1865–1916), who collected and studied the flora of the California Channel Islands. She donated numerous items from the Channel Islands, including plant collections, to the Academy, and was elected to membership in 1904 (Hittell 1997).

²⁰ According to Charles B. Turrill (page 12 of his typescript, see note 1 above), the Academy was offered 10 acres of land for a botanical garden in the new city of Clinton. "The offer was held under consideration while other localities were given an opportunity. While, no doubt, the Academy would have willingly established a botanical garden, provided means for it could be obtained, yet the members seem to have been unwilling to have the institution used as bait in a real estate deal. Where was Clinton? True the Academy has survived it. Few even remember the place. Its streets were surveyed beyond Oakland. Badger's Park was there years after." Hittell (1997:494) offered a somewhat less cynical perspective: "... it appeared that, while the maintenance of a Botanical Garden in Alameda County might be a great gain to the prospective City of Clinton, it would be a millstone around the neck of the struggling Academy, which was barely able to keep its head above water as it was; and the proposed magnificent donation was respectfully declined with thanks for the offer."

²¹ No collections attributed to Andrews are extant in the Academy's botanical collection. In the Torrey Herbarium at NY, there exists at least one collection made by "Dr. Andrews" in California. Andrews' specimen was apparently used by Torrey in the protologue of *Clintonia andrewsiana* Torr. (see Fig. 5B). Therein, Torrey (in Whipple, Pacific Rail. Rept. 4(4): 150. 1857 ["1856"]) noted, "The only specimens of this interesting plant found by Dr. Bigelow have the flowers scarcely expanded; but we fortunately, while this report was in press, received it in a more advanced state from Dr. Andrews, lately of California, and to this gentleman, who has assiduously examined the botany of that State, we dedicate the species. No ticket accompanied his specimens, but they were probably collected not far from San Francisco." Several other California plants (e.g., *Cirsium andrewsii* (A. Gray) Jeps., *Galium andrewsii* A. Gray), were named for him. "Dr. Newberry" refers to J.S. Newberry (1822–1892), geologist, physician, and naturalist-explorer who collected plants in the western United States. Following his work for the Williamson Pacific Railroad Survey expedition in 1855, which explored the lands between San Francisco Bay and the Columbia River, he settled for a time at Columbian College (now George Washington University) in Washington, D.C. to write his report on the expedition. Much of his herbarium, possibly including collections of Andrews, is at US and F (*Regnum Vegetabile* 109:590. 1983; for biographical information on Newberry, see <<http://www.mnh.si.edu/vert/fishes/baird/newberry.html>> and <<http://famousamericans.net/johnstrongnewberry/>>).

²² Letters of 8 June 1855, 7 August 1855, and 4 September 1855 from Andrews to Torrey are deposited in the Torrey correspondence at the New York Botanical Garden.

²³ Deborah Lewis of the Iowa State University Herbarium kindly provided additional information from a 1927 "Report on the Herbarium of Iowa State College" by L.H. Pammel, I.E. Melhus, and R.I. Cratty concerning Andrews' collections at that institution. On page 4 of that report, they noted that "Some twenty-five

years ago [i.e., from 1927], Dr. T.L. Andrews, a citizen of Mount Pleasant [Iowa] who had spent some time in Kansas, Louisiana, Tennessee, Brazil, and the islands of the Pacific, and Monterey, California, gave me his collection a short time before his death. He located at Monterey when it was the capital of California. This was soon after California became a part of the United States. The collection, therefore, proved to be a most valuable one." On page 17 the report indicated, "1847-1850. Six collections were made in Louisiana and Monterey, California, by Dr. T.L. Andrews." Other biographical information on Andrews noted herein is derived from the Biographical Review of Henry County, Starr's history of Cornwall (Connecticut), and the newspaper article from 1902 (a copy of which was kindly supplied by Ms. Lewis), all of which are cited in the text. These three sources contain many more details of his eventful life and collecting localities, but do not mention his affiliation with the Academy.

²⁴ Hittell (1997:40) indicated that "Dr. Behr appears to have been elected curator of botany, though the record is silent as to what had become of his predecessor in that position." In fact, his predecessor had departed San Francisco in the previous month.

²⁵ The California College of Pharmacy was organized in 1872 by the California Pharmaceutical Society and Behr was appointed as a professor of botany there in the same year (Legge 1953). The College soon became affiliated with the University of California.

²⁶ In 1969, ten percent of the residue of Margaret D. Bloomer's estate was presented to the Academy for the purchase of botanical books in memory of H.G. Bloomer in accordance with her will. Richardson (1970) recorded an interesting and detailed account of Bloomer, his descendants, and the fortune amassed through real estate speculation (\$20,402 of which established the Bloomer Book Fund in the Department of Botany).

²⁷ The extant records do not indicate who officially served as curator of botany in 1857.

²⁸ Although known to pre-Columbian Americans, the "discovery" of the Sierra redwood by non-natives was summarized by Peattie (1953) and Ewan (1973). Kellogg had received sterile samples of the species in 1852, but delayed publishing a description of the plant for which he lacked reproductive structures and which he had not seen alive. He did show the specimens at the Academy to William Lobb who had come to California to collect plants for a British nursery firm. Soon thereafter, Lobb located plants in the Sierra Nevada; collected seeds, fertile herbarium specimens, and living stock; and returned to England where he presented the specimens to John Lindley. Lindley quickly published Lobb's description of the plant, and named it *Wellingtonia gigantea*, in honor of the Duke of Wellington who had defeated Napoleon at Waterloo. Kellogg had intended to name the plant, "Washingtonia," for a hero of the United States, George Washington. Members of the Academy were not pleased with this sequence of events that resulted in their having "lost" priority for naming the species of the largest known plants. Another episode involving naming and priority of the discovery of some viviparous fishes also occurred at this time. At the meeting on 27 March 1854 (Hittell 1997:27-29), as a direct result of these perceived injustices, it was unanimously resolved, "that in view of the isolated condition of this Academy from other societies that we will regard every publication of new species which has been, or which may be made through the daily papers of this city, as substantial evidence of priority of discovery." Considerable angst and much discussion (including letters and publications) followed on the subject of the scientific name that should be applied to the species of giant trees from the Sierra Nevada. In print, the mild-mannered Kellogg referred to the plant as "the great Washington cedar" and indicated that this was "the earliest among common names, and claims precedence, by all courtesy, in point of time, as also in appropriateness of honor" (Kellogg 1882:19). Because of subsequent international nomenclatural regulations and taxonomic assessments, the species would become known botanically as *Sequoiadendron giganteum*—the generic name ultimately, and perhaps most fittingly, honoring a native American (Sequoia, a distinguished Cherokee chief). The tangible results of the disputes over priority in publication resulted later that year in the Academy's publishing its *Proceedings* as a scientific series, separate from the local newspapers in which they had previously appeared.

²⁹ Bloomer and others were on a collecting trip to Marin County (just north of San Francisco, across the Golden Gate) in September 1874, lost their way, and spent the night outdoors. At age 53, Bloomer died shortly thereafter, apparently partly as a result from over-exertion and exposure during the trip (Richardson 1970).

³⁰ Although funding for the botanical component of the Survey was eliminated in 1864, Bolander was hired to collect plants in regions of California where Brewer had not already done so; according to Ewan

(1953), he became "State Botanist" at this time.

³¹ The botanical volumes of the Survey, essentially California's first comprehensive floristic account, were eventually published in 1876 and 1880 at the expense of a group of interested and wealthy citizens. The treatments were prepared by Brewer, who worked on them from his position at Yale; Sereno Watson, a botanist at Harvard who was familiar with the western flora; and Asa Gray, one of North America's principal botanists. See Erter (2000) and Beidleman (2006) for accounts of the Survey—including its personnel, activities, accomplishments, and demise.

³² Sets of the Survey's plant collections are extant at Harvard's Gray Herbarium (GH), the University of California's herbarium (UC), and the Smithsonian's National Museum of Natural History (US). If a set was deposited at the Academy, as originally intended, most of them would have been destroyed in the 1906 earthquake and fire that devastated the Academy's herbarium. Among the type collections currently extant at the Academy, there are 55 collections of Bolander. Twenty-six of these are in the Dudley Herbarium (DS, which was incorporated with that of the Academy subsequent to the earthquake). Among specimens in CAS, 13 were received subsequent to the 1906 earthquake, but 16 of them were among the specimens saved by Eastwood in 1906 as recorded on her list. Also among extant types in the Academy's herbarium are 22 collections of Brewer, 13 in DS and nine in CAS. Two of the nine CAS collections were among the specimens saved by Eastwood in 1906. None of the specimens collected by Brewer and Bolander that were present at CAS prior to 1906 bear the "Geological Survey of California" labels that are present on specimens at UC, GH, and US. Rather, labels on these CAS specimens (e.g., Figs. 3C–D, 7A–B) are either California Academy of Sciences labels or handwritten labels bearing no organizational name. Duplicates of all 18 Bolander and Brewer specimens at CAS that were saved by Eastwood were sought at UC to compare labels and data. Of the six that were located there, most have printed "Geological Survey of California" labels, but a few have labels produced at a later time. None have "original" labels like those at CAS. Some of the information on labels at UC differs from that on labels at CAS: the label of *Hieracium bolanderi* at CAS lists the collectors as Bolander and Harford, whereas that at UC lists only Bolander; the label of *Lessingia leptoclada* at CAS does not provide a collection number whereas the label at UC does; the label of *Garrya buxifolia* at CAS notes that the collection was made by Bolander and Harford (with no number cited) in Mendocino and the southern part of Humboldt counties whereas the label at UC notes that *Bolander 6579* was collected in "Red Mts., Mendocino Co.;" the label of *Lathyrus torreyi* at CAS notes that Bolander's collection was made in Mendocino County whereas that at UC notes that it was collected "in thickets near the coast, Humboldt Co., Shelter Cove." in 1867; and the label of *Mitella ovalis* at CAS notes only that Bolander's collection was made in Mendocino County whereas that at UC notes that it was made near Noyo (in Mendocino County) in 1867. While it is possible that some of these collections may not represent true duplicates, it is certainly the case that more information is found on some specimens than others. Determinations of isotypes involving California Geological Survey specimens should involve the comparison of data (and plants represented) on the various specimens concerned. The pre-1906 specimens of Bolander and Brewer at CAS are undoubtedly remnants of a set (possibly the original set) of Geological Survey specimens that were deposited at the Academy before the bulk of the materials were sent East to be studied. Whether this set represented a complete set of the Survey's collections remains unknown. There are numerous specimens at the Academy with printed "Geological Survey of California" labels (many of which were received from US), that came to the institution subsequent to 1906. Thus, a subset (of unknown magnitude) of the Geological Survey specimens resides at CAS.

³³ Harkness was elected as president from 1887 through 1895. He was originally elected as an "opposition" candidate amidst considerable controversy at the Academy. Some opposition to his continued presidency appeared during his tenure in office (e.g., there were several "opposition ballots" or "opposition candidates" offered during the annual elections; Hittell 1997). Indeed Harkness was sometimes blamed for the rancor and internal divisions that prevailed at the Academy during his tenure there (e.g., Bosqui 1952; see also note 38 below).

³⁴ Kellogg was also interested in fungi and presented several mycological papers to the membership (Hittell 1997).

³⁵ Most of these specimens were destroyed in the 1906 San Francisco earthquake and fire (but see note 73 below regarding Harkness types that were saved). When the Dudley Herbarium of Stanford University was incorporated with that of the Academy, most of the fungal collections from both institutions were deposited

at BPI; the CAS collection of macrofungi from Chiapas and the Robert Orr collection of macrofungi were subsequently transferred to NY in 2001. The Chiapan collections were mostly those of D.E. Breedlove. Robert T. Orr (1908–1994) was a curator of ornithology and mammalogy at the Academy and had an interest in fungi. He informally curated the fungal collections in Department of Botany for many years and bequeathed his personal collection to the Academy.

³⁶ Although it is established that Moore was born on May 8th, the year of his birth is uncertain. Because the minister who baptized him died, the church with its records of births was destroyed by fire, and his mother and the birthing nurse subsequently disagreed on the year (his father apparently agreed with the nurse), the year usually given (1841) might be off by one (according to a letter dated 3 January 1934 from J.P. Moore's widow, Charlotte D. Moore, to J.H. Barnhart, a copy of which is in the Eastwood archives, C.A.S. Special Collections).

³⁷ Among the George Davidson papers at the University of California's Bancroft Library in Berkeley there are 16 letters written by Moore between 1881–1890, primarily to Davidson. Some anecdotal and circumstantial evidence that Rev. Moore and Academy mycologist Moore were the same person can be found among several biblical quotations noted in his letters to Davidson. For example, in disparaging conditions at the Academy of Sciences of Chicago, he noted it is "in the condition of one of the Seven Churches about whom the Apostle John writes in Revelation, it 'has a name to live and is not.'"

³⁸ As stated in two letters to Davidson (20 September 1886 and 2 November 1886, both preserved in the Davidson papers at the Bancroft Library), Moore indicated that his resignation was prompted by his extended absence from the Academy combined with the need to have a quorum at meetings of the institution's governing council. These and other letters reveal his sympathies and alliances in the internal political struggle that took place at the institution in the 1880s (see note 33 above). The exact nature of these problems was not revealed by Hittell (1997), who merely noted that antagonism between president George Davidson and first vice-president H.W. Harkness had been growing for some time prior to the annual election of officers in January 1886. This antagonism, "which to a considerable extent involved their friends" (Hittell 1997:227), resulted in an opposition slate of candidates at this election consisting of Moore for first vice-president and John T. Evans for second vice-president. Both opposition candidates were elected, replacing Harkness and H.H. Behr respectively. Moore greatly admired Davidson, and in letters to him made references to "fungoid growths" at the Academy and "our ancient fungoid friend," undoubtedly in reference to Harkness. Moore allied himself with Harford, Kellogg, G.E. Gray, W. Churchill, and C.G. Yale. His disassociation from the institution likely resulted, at least in part, from Harkness's ascension to the presidency, on another opposition slate, in the "hotly contested" election of 1887.

³⁹ Letter of 24 October 1933 from Charlotte D. Moore to Alice Eastwood; copy on file in Eastwood archives, C.A.S. Special Collections.

⁴⁰ The Association was organized in San Francisco in 1876 to seek improvement in insurance matters; it was later renamed the Insurance Underwriters Association of the Pacific; and in 1966 the name was changed to the Insurance Educational Association (fide IEA website: <<http://www.ieatraining.com/about/index.asp>>, accessed 28 June 2006).

⁴¹ Jones (1933) contended that she was born in Carson City, Nevada, but her autobiographical notes, as quoted in Setchell (1926), indicate otherwise.

⁴² Because there were other women successfully practicing medicine in San Francisco at that time (Ertter 2000), her giving up medical practice cannot be attributed solely to the fact that she was a female doctor. Setchell (1926) merely stated that she did not find the practice of her profession lucrative. Curran allowed only that, "a young doctor is not usually overrun with patients" (quoted in Setchell 1926:167). It is possible that her temperament and growing interest in botany conspired with financial realities and lead to a change in profession.

⁴³ Among those first women was Sarah A. Plummer, an amateur botanist and plant collector, who later married John G. Lemmon.

⁴⁴ Salaries for curators at that time were the exception rather than the rule. Curators were still expected to draw their salaries from their professional lives outside of the institution. In awarding her a salary, the Council of the Academy noted the time and expense she had already contributed to curating the herbarium.

The funding given Curran in 1883 does not appear to have been an on-going salary, but rather an ad-hoc action of the Board of Trustees. There is no mention of Curran having received such funding in 1884; however, beginning in 1885, she (along with Kellogg and Greene) received annual payments as determined by the Trustees (Hittell 1997).

⁴⁵ The *Bulletin* was instituted in 1884 because publication of the *Proceedings* had been suspended and some institutional publication outlet was needed (see note 11 above).

⁴⁶ According to Curran (subsequently K. Brandegee; as quoted in Setchell 1926:168), soon after its inception, "Dr. Harkness found it too expensive and Mr. Brandegee took over the control, repaying to Dr. Harkness the sum that he had expended. Highly opinionated commentator Marcus Jones (1933:16) described *Zoe* as "the only highclass magazine on the Pacific Coast." Although it was privately owned, 50 copies of the first two volumes of *Zoe* were offered to the Academy "to be distributed among the principal scientific societies of the world with which the Academy was in correspondence 'in grateful acknowledgment of favors granted to the California Zoological Club and the California Botanical Club'" (Hittell 1997:335). *Zoe* also published a summary of the Academy's activities under a section entitled "Proceedings of Societies."

⁴⁷ She was editor of volume 1 of the second series of *Proceedings of the California Academy of Sciences*, the first papers of which were issued in 1887.

⁴⁸ Greene's eventful life (including his collecting plants while serving as a Union private during the Civil War, his conversion to Catholicism and subsequently being locked out of his Episcopal church in Berkeley, and his post-Berkeley days at the Catholic University and Smithsonian Institution in Washington, D.C.) makes for interesting reading.

⁴⁹ By then, after her marriage to T.S. Brandegee, she was known as K. Brandegee.

⁵⁰ Was this Bruyn Hasbrouck Davis (1827-?) whose brother, Horace Davis, was a San Francisco businessman, politician, and university administrator? Horace Davis was proposed for membership in the Academy in 1894, and in 1903 he was appointed to a committee charged with overseeing the establishment and awarding of an Academy medal for agricultural advancement (Hittell 1997). The Davis brothers were sons of Massachusetts governor and senator, John Davis (Estabrook 1908). Paradoxically, Bruyn Hasbrouck Davis (born Worcester, Massachusetts; graduated Williams College in 1845 and thereafter studied in Germany; taught high school in Worcester; became pastor of the Unitarian Society in Watertown, Massachusetts in 1849; studied law and admitted to the bar in Massachusetts in 1854; moved to Chicago in 1855; mustered into the army of the United States in 1862 as lieutenant colonel of the 11th Illinois cavalry; served with distinction, and at close of the Civil War was brevetted brigadier general; after returning to Chicago, he was elected city attorney) was reported as lost on a voyage to Ireland aboard the steamer *Cambria* in 1870 (<http://famousamericans.net/johndavis4/> accessed: 27 June 2006). I have been unable to reconcile his apparent death in 1870 and his Academy activities nearly 20 years later; no others in the Davis family with the name "Hasbrouck" were noted by Estabrook (1908). In spite of various coincidences, it would appear that Academy curator Hasbrouck Davis and Bruyn Hasbrouck Davis were not the same person.

⁵¹ She was a strong supporter of Harkness, who was perceived by some as rather high-handed and outspoken (e.g., Bosqui 1952).

⁵² He had received a legacy of \$40,000 (Jones 1933) sometime after arriving in California. Ewan (1942) speculated that receipt of these funds likely helped to influence Brandegee to give up survey work in favor of botany.

⁵³ This is not to be confused with the California Botanical Society, which was founded 22 years later (1913) in Oakland by W.L. Jepson. The California Botanical Club was founded on 7 March 1891 in response to a call from: Harkness, Behr, Eisen, K. Brandegee, T. Brandegee, Mary W. Kincaid, and Agnes M. Manning. They sought "to promote the study of plants, especially those found on the Pacific Coast of North America, and by bringing into more intimate relations the botanists of the Coast to arouse a greater interest in so rich a field of science" (Anonymous 1891b:93). This was the first botanical organization on the Pacific Coast of North America. Membership soon surpassed 100 and included professional botanists, prominent avocational botanists, and local plant enthusiasts. Meetings included presentation of botanical papers and field excursions to local sites. The Club met at the Academy and supported the institution by providing specimens for its herbarium (via collections and purchases). Membership dues to the Club included a subscription to *Zoe* (East-

wood 1941), and thus the Club helped to finance that journal. Although K. Brandegee was apparently never president of the Club, it is clear from later references (e.g., Eastwood 1941) that she was the active force behind it. Eastwood assumed leadership of the Club following Brandegee's departure from San Francisco in 1894. The Club became increasingly social in its activities, although a botanical lesson or discussion was always at the center of its gatherings and field trips. By 1913 (following destruction of the Academy's buildings and resources in 1906) membership in the Club numbered about 50. They met weekly, alternatively at the Academy and on excursions in the field. The Club helped the rebuilding efforts in the Department of Botany by providing volunteer labor and by purchasing specimens and library materials that had been destroyed in 1906. It also helped to finance Eastwood and Howell's *Leaflets of Western Botany* (Eastwood 1941). Howell assumed leadership of the Club in 1953. In unpublished archival records in the Academy's Library and Special Collections, he noted, "As the Club was conducted by Miss Eastwood after the 1906 S.F. Earthquake it was a weekly field trip—an afternoon walk in Golden Gate Park or an all-day excursion out-of-town, generally to Marin Co., less often to the Eastbay or down the Peninsula. This was the *modus operandi* when I first came to the Academy in 1929, but it stopped abruptly when on July 25, 1931, Miss Eastwood was hit by an automobile and was crippled by a broken leg. After her recuperation and return to work at the Academy, the meetings of the Botanical Club became round-the-table discussion meetings in the Botany Dept. and this was the Club activity I inherited after Miss Eastwood's death in 1953. The discussion type of meeting continued but it was a bit more serious, not quite so homey and social." Howell also led the Club's members on extended trips to botanically interesting regions of California (e.g., in 1968, he led the Club on a 6-day field trip across the Sierra Nevada in what was billed by the Club as a "Trans-Sierran Phytogeographic Expedition." The 40 participants in 14 vehicles drove more than 800 miles from sea level to 11,000 feet (Academy Newsletter 345, September 1968). Plant lists were compiled during these botanical outings and Howell usually prepared a trip report for the membership. In the years following Howell's retirement from the Academy, Ann Witter (Gillette) (a longtime member of the Club and Trustee of the Academy) played a major role in running the organization. On the Club's centennial in 1991, Howell and Witter relinquished leadership of the group. Club member and Department of Botany associate Catherine Best took over organizational responsibility for it until 1996. By 1995, regular monthly meetings had yielded to a few field trips each year, a garden party in May, and a Christmas party in December. The last of the Club's major activities were trips to Sonoma County in 1997, including an outing to the Academy's Pepperwood Ranch (C. Best, pers. comm.). The Club's assets were eventually donated to the fund for the Howell Chair in Western American Botany at the Academy.

⁵⁴ The first meetings of the Academy had been in the offices of businessman Lewis W. Sloat on Montgomery Street and attorney Thomas J. Nevins in the Phoenix Block building on Clay Street. Meetings continued in Nevins's office for more than a decade but its quarters there were small and inadequate (Hittell 1997) for the increasing membership and contributions of specimens to "the cabinet." In 1863, Hittell (1997:68) noted that "Professor Bolander was authorized to obtain subscriptions for cases to contain the botanical collections." By 1866, the Academy's various collections had been relocated to a hired room for safe keeping (Hittell 1997) following damage to the Phoenix Block building resulting from an earthquake in 1865. The Academy relocated to rooms in the Donohoe Building on the corner of Montgomery and Sacramento streets in May of 1866, but it is not recorded if or when the collections were moved to that site. By December of that year these rooms had become inadequate and the Academy moved back into repaired and refitted rooms in the Phoenix Block building in time for its first meeting in January of 1867. From 1874 until 1891 the Academy rented the old First Congregational Church building on the southwest corner of California and Dupont (now Grant) streets. There, the herbarium and botanists were located in the gallery of the old church (Anonymous 1922). With the opening of its own building, the Academy's botanical collections were moved from their "dark, dingy, dusty and dilapidated old quarters on Dupont Street to the bright, airy and well-kept galleries on Market Street" (Fig. 13B; Hittell 1997:442).

⁵⁵ Botany, as a discipline, was present at the Academy from the founding of the organization, but it is unclear exactly when the "Department of Botany" came into existence. One can infer that there was a department of botany from the inception of the institution when there was a curator and cabinet of botany. Scientific departments at the Academy, in their modern guise, apparently came about somewhat later, however. Hittell (1997:22) noted that, "The first effort to form a section of the Academy was made on NOVEMBER 21 [1853], when, on motion of Dr. William P. Gibbons, a "Floricultural and Horticultural Department," also

called an "Agriculture and Horticulture Committee," was organized by Gibbons, Kellogg, Nevins, Randall and Bloomer, of which Gibbons was elected chairman and Nevins secretary." Hittell (1997) made no further reference to this section or committee and its creation or demise remains undocumented. Hittell (1997:105) noted that in 1869, as a result of Academy vice-president J.G. Cooper's move to establish divisions of members along disciplinary lines, "Dr. Kellogg proposed a botanical division to include meetings in the field." Based on the lack of subsequent references to such divisions by Hittell (1997), it does not appear that they were formally established at this time. However, in 1876, a committee was appointed to consider "sectionizing the Academy" and their recommendation to create sections of the Academy for particular subjects of study and research was subsequently adopted (Hittell 1997:192). Hittell (1997) noted the formation of numerous sections at the Academy over a period of years, but not one in botany. Among the Academy's historical records, however, there is a ledger entitled "Botanical Section of the California Academy of Sciences. Organized March 31st 1877." This book indicates that a botanical section was organized during a meeting on 31 March 1877 attended by Behr, Kellogg, Harford, Henry Edwards (curator of entomology at the Academy), and Elisha Brooks (for many years treasurer of the Academy). At that organizational meeting, Edwards was elected president of the section, Harford was elected secretary, and Kellogg was elected conservator of the herbarium. Goals of the section were investigation of the flora of California and adjacent regions of the Pacific Coast, registration of localities of rare and little-known plants, formation of a new herbarium, and collection of specimens. The ledger contains minutes of meetings of the section up to 13 October 1877. At the meeting of 14 April it was decided that information about plants found [and presumably collected] by members of the section was to be recorded in a book. This latter catalogue ("Record of the Botanical Section of the California Academy of Sciences. Formed April 1877") is also extant in the Academy's Special Collections (California Botanical Club, Box #1). It contains some 48 pages with information (mostly locality and date) from collections added to the herbarium, including those of Kellogg, Kellogg & Harford, Behr, Eisen, Moore, Edwards, J. Clarke, J. Lemmon, and others. That is followed by a "List of Professor Green's [sic] Species." Notes from the early years of the Academy as reported by Hittell (1997), often make reference to "departments," but this was usually used in the sense of "discipline." This may have been an unintentional mischaracterization on Hittell's part, because in museum director Bloomer's report to the meeting of 3 January 1871 (Proceedings of the California Academy of Sciences 4:156. 1872), he referred to various departments (including a botanical one) in their modern sense. By the early 1880s even Hittell (1997:233) noted that curators were being asked "to hand in lists of all property in their respective departments." In 1892, reference is made by Hittell (1997:338) to "the Botany Department," and thereafter, one finds numerous references to the Department of Botany in its modern sense.

⁵⁶ Jones elevated acerbic critique of his colleagues to a literary style. For example, describing botanist and Academy member C.C. Parry, he stated, "Parry was a typical toady, as most men had to be to get a position in the Government service. He was a suave, well groomed society man with little brains, a great feeder of hot air, who slobbered over the great to keep in their good graces" (Jones 1930:3). For the most part, Jones's had only praise for K. Brandegee: "She was incontestibly [sic] the greatest woman botanist that ever lived" (Jones 1929:16) and "she became a walking encyclopedia on California botany" (Jones 1933:14). A thorough summary of Jones' life, writings, and collecting localities was provided by Lenz (1986).

⁵⁷ Although such critiques might be considered "unprofessional" by current standards, these types of published comments were neither unique to K. Brandegee nor uncommon during this period in which private journals flourished.

⁵⁸ Most of K. Brandegee's collections at the Academy were destroyed in 1906, but duplicates of her collections are extant in herbaria at the University of California and elsewhere (Thomas 1961a).

⁵⁹ I doubt that Ewan was truly offering an accusation against K. Brandegee. Rather than being a "sin" of commission, this was likely one of omission, which was the general practice among plant collectors at the time. Indeed, information on labels of her successors, Eastwood and Howell, is often similarly lacking in details of locality, habitat, and morphological attributes such as habit, plant height, and flower color. Ewan was likely expressing the frustration that many botanists feel about the general lack of data provided on the vast majority of older plant collections.

⁶⁰ Ewan's (1942:773) comments on K. Brandegee's motives for field work (e.g., a focus on recollecting "topotypes" and a preoccupation "to seek out intermediates for proposed new species and depose them and

their proponents in the columns of *Zoe*") might help to explain her later failure to publish the results of her botanical studies.

⁶¹ George Thurber (1821–1890), elected a corresponding member of the Academy in 1863, had been a botanist with the U.S. and Mexican Boundary Survey in 1850–1853. His collection acquired by the Academy, which undoubtedly included a set of his own collections as well as collections of others (e.g., F. Lindheimer; see McKelvey 1955:911), was destroyed in 1906. Surviving sets of Thurber's collections are at US, NY, and GH. See Ewan (1950) for additional biographical information on Thurber.

⁶² Lindsay (1968) indicated that K. Brandegee left the Academy's employ when David S. Jordan became president because she was unhappy with the new regime. It was fortunate that the Brandegees took their personal collections with them when they left the Academy in 1894; otherwise, most or all of them would have perished in 1906.

⁶³ By September of 1900, K. Brandegee's successor, Alice Eastwood, had learned that the Brandegees intended to return to the Bay Area from San Diego, "owing to the enervating effect of the climate" on Ms. Brandegee (Eastwood to K. Brandegee, 6 September 1900, letter preserved in the archives of the University and Jepson herbaria at the University of California, Berkeley). Eastwood graciously indicated to her that, "There is a table for you whenever you may come, a place where you can spread out to your hearts content" (Eastwood to K. Brandegee, 25 September 1903, letter preserved in the archives of the University and Jepson herbaria at the University of California, Berkeley). Brandegee's dependence on Eastwood to supply plants and information from herbarium specimens, as reflected by her frequent requests to Eastwood, suggest that an additional reason for leaving San Diego was to return to a center of botanical activity.

⁶⁴ The Brandegees' personal herbarium consisted of 76,166 specimens (Ertter 2000), largely from California and Baja California, where their respective interests led them on collecting trips. It was rich with type specimens of names they had proposed from these regions. The addition of the Brandegee Herbarium effectively doubled the size of the herbarium at the University of California. Their reasons for donating their botanical legacy to the University of California rather than the Academy have not been recorded. Ertter (2000) provided some interesting speculation on this matter as well as on the post-Academy relationship between Eastwood and K. Brandegee. Ultimately, the Brandegees had originally hoped to receive some financial remuneration for placing their herbarium at the University; although this did not happen, the University had resources that the Academy lacked in the wake of the earthquake and fire of 1906. Katharine Brandegee did not sever ties with the Academy after moving to San Diego. For many years she and Eastwood maintained a correspondence wherein Brandegee was kept informed about botanical activities at the Academy, mutual acquaintances, and Eastwood's field trips (letters from 1894 through at least 1912 are preserved in the archives of the University and Jepson herbaria at the University of California, Berkeley). Eastwood also sent plants to Brandegee, and she researched her mentor's innumerable inquiries about types and other specimens when Eastwood was visiting herbaria in Europe and the eastern United States. Hittell (1997) noted that in 1897, K. Brandegee donated 200 California plants to the herbarium, and that in 1898 she donated 85 species of Mexican plants.

⁶⁵ Thomas (1969) noted that K. Brandegee collected through 1918.

⁶⁶ One might suspect that growing up in this environment in some way preadapted Eastwood for work in a major natural history museum.

⁶⁷ Eastwood's life and activities during her formative years in Colorado have been summarized elsewhere (e.g., Wilson 1955; Gambill 1988).

⁶⁸ According to unpublished archival records at the Academy, in 1894 Eastwood and William R. Dudley (Fig. 11A) were both curators of botany. Dudley (1849–1911) was born in North Guilford, Connecticut and studied botany at Cornell University where he received an M.S. degree in 1876. He had been recruited to Stanford University from the Cornell faculty in 1892. He was elected to membership at the Academy in 1893 and was noted to have presented a paper to the membership in 1901 (Hittell 1997). During his tenure as professor of botany at Stanford, he collected plants in California, built an herbarium, and trained students. Dudley's California collections, the collections he had brought with him from Cornell, his students' collections, and a gift of about 70,000 duplicate collections from William Harvey's personal herbarium (at Trinity College in Dublin, Ireland) became known as the Dudley Herbarium of Stanford University following his death from tuberculosis (Thomas 1969; Ertter 2000). Except for the personal collections that Dudley had brought to Stanford from

Cornell, the entire Dudley Herbarium was eventually amalgamated with the Academy's herbarium. Dudley's personal collections from western New York State presumably remain at Stanford University, although their whereabouts there are not known (S. Thomas, pers. comm.). A genus of Crassulaceae, *Dudleya* Britton & Rose, was named in his honor. Additional biographical and bibliographical information about Dudley is available from Jordan (1911), Thomas (1961a, 1969), and Greene (1981).

⁶⁹ Eastwood received from the Board of Trustees an appropriation of \$87 to defray travel and collecting expenses in 1894 (Hittell 1997). Also, her train fares were provided gratis for the most part. Prior to her resignation, K. Brandegee had arranged for a 1,000-mile free ticket on the Southern Pacific Railroad to be used by the curator of botany (Wilson 1955).

⁷⁰ Summaries of some of Eastwood's collecting activities were provided by Wilson (1953, 1955) and Twisselmann (1967).

⁷¹ In 1896, Eastwood noted that she added between 5,000 and 10,000 plants to the herbarium each year (in a letter to J.N. Rose, quoted by Leviton and Aldrich 1997).

⁷² In fact, the "disagreement" over the title of the "Nob Hill" paper did not appear to greatly disrupt their professional relationship. She was a frequent contributor to *Erythea*; in 1896 Eastwood was listed on the title page of volume 4 as having assisted the editor; and she continued to publish articles in the journal following Jepson's alteration of her title. Indeed, volume 7 of Eastwood's copy of *Erythea* (presented to the CAS library by Eastwood in 1949) was inscribed "Miss Eastwood, with the compliments of W.L. Jepson." They must still have been on fairly good terms in 1900 when in the published notice of the discontinuation of *Erythea*, Jepson thanked Eastwood for her recent services in assisting with the journal. However in 1906, Jepson described her in his notes as, "more cocksure and unscientific than ever" (Ertter 2000:244).

⁷³ This is the figure for the number of herbarium specimens saved noted among records in the Academy's archives and also by Howell (1953) and Wilson (1955). A complete list of the plants saved in 1906 was prepared by Eastwood and is extant in those archives. This is probably the inventory she made of the specimens following their rescue and before they were transferred to the vault in the Crocker Bank that was referred to by Wilson (1955). It reveals that 1,017 "types" of vascular plants and 480 "types" from Harkness' collection of fungi were saved. Other figures have been promulgated (e.g., 1,200 noted by MacFarland et al. (1949) and Lindsay (1968); Evermann (1916) indicated that 1,136 specimens of phanerogams (including 711 types) and 475 types of fungi were saved, for a total of 1,611 specimens). Other specimens from the Academy's pre-1906 collection survived because they were on loan at the time of the fire and were subsequently returned (e.g., most *Gilia*, some *Ptelea*, some *Eschscholzia*, most *Lupinus*, some *Delphinium*).

⁷⁴ See Miller (1942, repeated in Ewan 1955) for a listing of what was saved/salvaged from earthquake and fire.

⁷⁵ Details of Eastwood's heroic efforts in saving plant specimens from the Academy's herbarium have been drawn from several sources including Wilson (1955), a letter from Eastwood to E.L. Greene (see Duncan 2006), a letter from Eastwood to E.W. Nelson (reproduced in Hittell 1997), and her own recollections as reported by Mike Stein in his article for the San Francisco Examiner of 18 April 1953, "Alice Eastwood Recalls Terrible Times in 1906." As with many stories that take on the status of "legend," specific details sometimes vary from one account to another.

⁷⁶ Because of its location in San Francisco, which lies near several major faults associated with the boundary between the North American and Pacific tectonic plates, earthquakes have affected the Academy's herbarium and Department of Botany several times. An earthquake in 1865 damaged the Academy's quarters at 622 Clay Street "to such an extent as to induce those in charge of the library and collections to pack them up and store them where they would not be exposed to the weather" (Hittell 1997:79). In 1868 another serious earthquake shook San Francisco and the resulting economic reverberations threatened the Academy's income (Ewan 1955). Most of the destruction to the Academy's holdings in 1906 was caused by the fire following the earthquake, not from the temblor itself. In a report by Sewell (1907:76) it was noted that the "building had cast-iron concrete-filled columns and Ransome reenforced-concrete floor construction. So far as it was possible to ascertain, no damage was done to the reenforced concrete or to the columns by the earthquake. The building was gutted and the floors considerably damaged by the fire, but the columns were not damaged, and on the whole the building stood very well." The Loma Prieta earthquake of 1989 caused the third floor of

Wattis Hall, where the Department of Botany was located, to shake violently. Free-standing, standard herbarium cases shuffled up to six inches from the walls, books fell from shelves to the floor, library shelving was bent, ceiling tiles fell, and gaps between the closed compactor units opened and shut. Less than a dozen specimens fell to the floor from the compactor units with open shelving. Major damage was sustained in the Hohfeld Botany Library where hundreds of books fell from the shelves to the floor, and the metal shelving was destroyed. For more than a year thereafter, the Hohfeld Botany Library was housed in the Academy's main library. New shelving was purchased and most of the books that were damaged were repaired. In spite of the intensity (7.1 magnitude on Richter scale) of the 1989 earthquake, the Department of Botany sustained no permanent losses as a result of it. Possibly, some of the lessons of 1906 had been learned, yet good luck, improved construction techniques, and the absence of fire undoubtedly figured prominently in preventing more damage in 1989.

⁷⁷ Of these, 45,234 were mounted specimens and 15,476 were unmounted specimens [total = 60,710]; 60,638 specimens were determined whereas 8,832 specimens were undetermined [total = 69,470]; 52,949 were vascular plants and 7,689 were non-vascular plants [total = 60,638]. The total number of species of vascular plants was reported to be 19,586; the number of species of non-vascular plants was 2,838; and the number of genera represented in the herbarium was given as about 3,500. I am unable to derive the total number of specimens noted from the various categories provided, but consider the 74,767 figure to be reasonably accurate.

⁷⁸ Other occupants of the herbarium at that time were the Brandegees and Jepson, a situation that likely made for either very awkward or very interesting interactions (see Erter 2000 for an example).

⁷⁹ Details of her activities and travels following the 1906 disaster were recorded by Wilson (1955).

⁸⁰ Scattered Academy possessions had been reassembled on one floor of the Security Building at 343 Sansome Street in March of 1910, but accumulating gifts to the herbarium had been stored in the dark basement, where it was not possible to work (Wilson 1955). So Eastwood rented a floor of an old house on Laguna Street where she lived and worked on sorting the accumulating specimens from the basement on Sansome Street. Appropriate space was eventually made available for the herbarium and Eastwood's work at the Sansome Street headquarters of the Academy. With the completion of North American Hall in Golden Gate Park, the collection was moved to its new quarters on the second floor of that building's research wing in 1915.

⁸¹ The schooner *Academy*, bearing its assortment of valuable collections, returned from the Galapagos Islands to San Francisco on 29 November 1906. An extensive report on the plant life of the archipelago and on the botanical collections was published by the expedition's botanist, Alban Stewart, in 1911 (Stewart 1911). This was soon followed by other botanical results of the expedition (Stewart 1912a, 1912b).

⁸² By 1914, 12,000 mounted specimens had been made accessible in the Academy's temporary quarters (Grunsky 1914); by 1916, 20,586 mounted sheets were in the herbarium (Evermann 1916).

⁸³ See Eastwood (1952) and note 129 below. Although the pre-1906 Academy herbarium undoubtedly consisted of a large majority of collections from California and elsewhere in North America, it is abundantly clear from Hittell (1997) that earlier Academy curators, especially Kellogg and Bolander, were active in procuring plants (mainly via exchange or gift) from many parts of the world (e.g., Algeria, Australia, Chile, Europe, Greenland, Mexico, New Caledonia). One such donation noted by Hittell (1997:217) in 1878 was a collection of "plants collected on the Great Wall of China by the late B.P. Avery."

⁸⁴ Eastwood's horticultural activities were summarized by Wilson (1955). Her conservation ethics and activities were outlined by Howell (1954a) and detailed by Wilson (1955).

⁸⁵ Eastwood's collections from her early years in Colorado were donated to East Denver High School and eventually went to the University of Colorado at Boulder. The CU Museum Herbarium's Specimen Database of Colorado Vascular Plants (<<http://cumuseum.colorado.edu/Research/Botany/Databases/search.php>>; accessed 21 May 2007) and the Type Specimen Database of the University of Colorado Herbarium (<<http://cumuseum.colorado.edu/Research/Botany/Databases/typeSpecimens.html>>; accessed 21 May 2007) indicate the presence there of 1,429 Eastwood collections from Colorado collected between 1881 and 1910, with the greatest number of collections (291) for a single year having been made in 1891. Most of her pre-1906 collections at the Academy were destroyed in the fire there, but duplicates of many survive in other herbaria (e.g., A, GH, US). Her subsequent collections and field notebooks are extant at CAS.

⁸⁶ Not to be confused with either Thomas Jefferson Howell (1842–1912, the Oregon botanist) or John Hunter Thomas (affiliated with Stanford University and later with the California Academy of Sciences as a part-time curator of botany).

⁸⁷ Howell worked at the Garden during the summer of 1927 and from June 1928 until March 1929. During September 1927 to May 1928, he was an instructor in botany at the University of California, Los Angeles (Howell 1967).

⁸⁸ Smith (1989) provided an account of Howell's long and distinguished career, including revealing details from his tenure at the Rancho Santa Ana and his hiring by and joint work with Eastwood. Smith was a member of the Botany Club and one of Howell's "disciples." Her article was based largely on interviews she conducted with Howell.

⁸⁹ In Eastwood's "Report of the Botanical Department for 1931 and 1932" (Department of Botany archives, Box 1, C.A.S. Special Collections), she noted, "For publication of new species, interesting notes on introductions to the flora, and other matters of general botanical interest, Mr. J.T. Howell and I started in 1931 'Leaflets of Western Botany,' a small quarterly publication. We hope to make it the leading botanical magazine of the west. At present the subscribers are not sufficient for its support. Mr. Howell and I assume all responsibility, financial and otherwise, since we realize the importance of prompt publication which otherwise could not be secured." In addition to papers by Howell and Eastwood, the journal provided a publication outlet for many others interested in the flora of western North America, including many amateur and young professional botanists. The journal was closed after 10 volumes in 1966, two years before Howell's official retirement from the Academy. A comprehensive index to the journal, compiled by Howell and Anita M. Noldeke, was published in 1968. The journal was owned and published by Eastwood and Howell until Eastwood's retirement in 1949; beginning with volume 6 in 1950, Howell was the sole owner and publisher. Additional funding for the journal was received from various sources (as noted in the volumes) including: the Academy, the Botany Club, and various individuals. Although "*Leaflets*" was a private journal, Eastwood and Howell refrained from making or including the personal attacks and vicious criticisms that characterized many of its predecessors (e.g., Zoe or Marcus Jones's infamous *Contributions to Western Botany*). Although this might be attributed in part to changing times and increasing professionalism among Western botanists, it is likely due more to Eastwood and Howell's particular personalities, which seemed to be more inclined toward constructive comment than remonstrating against colleagues.

⁹⁰ Due to financial constraints on the Academy during the Great Depression of the 1930s, "official Academy field trips in all departments were cancelled, departmental expenditures were cut to bare subsistence [sic] level, and curatorial salaries (including Miss Eastwood's and mine) were cut ..." (unpublished typescript of 4 April 1975 by J.T. Howell, "Alice Eastwood and John Thomas Howell (mostly concerning Eastwood & Howell field work)," Howell Archives, C.A.S. Special Collections). As a result, Howell felt that Eastwood's sponsorship of their extensive field activities during this period should be counted among her most important contributions to botany at the Academy.

⁹¹ The first set of Howell's collections is at CAS and his collection notebooks are deposited there as well. The final number in the last (vol. 68) of his notebooks is 54,754, collected in Tulare County in 1984. This was about the time he moved from his home in San Francisco to a retirement facility in Marin County. He continued to collect plants (mostly weeds in the vicinity of a vegetable garden in Terra Linda) until a year or two prior to his death, but he neither numbered these collections nor recorded them in a notebook. Only a few dozen of these latter collections were ultimately accessioned at CAS.

⁹² Howell had previously traveled with Templeton Crocker to Guadalupe Island in November 1931 (Howell 1967).

⁹³ Very likely, the only larger collection by an individual was the one made by Stewart (more than 3,000 numbers) during the Academy's 1905–1906 expedition to the Galapagos Islands.

⁹⁴ Letter of 25 January 1951 from J.T. Howell to Members of the California Botanical Club (California Botanical Club archives, Box #3, C.A.S. Special Collections).

⁹⁵ Ground was broken for this building on 19 August 1958 and the last of the Department's 415,202 specimens was transferred to the new quarters on 25 June 1959 (Department of Botany archives, Box 1, C.A.S. Special Collections).

⁹⁶ Robert Miller (Pacific Discovery 12(1):8–13. 1959) provided historical perspectives on the Academy's library up to this time.

⁹⁷ The Department occupied 9,784 square feet of space and the collections were housed in 348 herbarium cases in 1968 (Lindsay 1968).

⁹⁸ Howell's unprocessed Sierra Nevada materials were estimated to contain more than 40,000 specimens representing some 18,000 collections.

⁹⁹ Many of these publications either have been, or are currently being, revised and republished.

¹⁰⁰ At the dedication of the new departmental facilities in Wattis Hall in 1976 it was announced that Ms. Edward Hohfeld had provided the initial funding for this chair. The endowment continued to grow by additional gifts and investment returns, and attained the activation goal of \$2,000,000 in 2006.

¹⁰¹ With California's diverse climates, including an extensive region of Mediterranean climate, plants from most regions of the world can be cultivated somewhere in the state. An interest in horticulture at the Academy predates Eastwood and can be traced to several of the Academy's founders. Some of the Academy's contributions to horticulture were summarized by Reitter (1953).

¹⁰² This journal is a successor to the *Journal of the California Horticultural Society*, and McClintock succeeded Howell as its botanical editor in 1953–1954.

¹⁰³ Renamed the San Francisco Botanical Garden at Strybing Arboretum in 2004, this is San Francisco's municipal botanical garden and arboretum. It is located adjacent to the Academy's facilities in Golden Gate Park.

¹⁰⁴ Her opposition to the "Panhandle freeway" and development near Ocean Beach is chronicled in various articles in San Francisco newspapers, e.g., *San Francisco Chronicle* ("Sandstorm" Warning" 1 May 1964, page 2) and *San Francisco Examiner* ("Rare plant still plagues beach developments" 21 January 1983, p. B1). The latter article notes that her statements about the endangered dune tansy became a factor in the delay of one project, which indirectly led to a developer's bankruptcy.

¹⁰⁵ With the enactment of an employee retirement plan at the Academy in 1964, mandatory retirement at age 65 was put into effect for most employees (A. Leviton, pers. comm.). In 1978, amendments to the federal Age Discrimination in Employment Act prohibited mandatory retirement for the most part, and the practice was discontinued at the Academy.

¹⁰⁶ Annetta M. Carter (1907–1991) was a much-admired botanist who worked at the University of California's herbarium in Berkeley. Her primary interest was in the flora of the Sierra de la Giganta of Baja California Sur. She participated in Academy expeditions to the peninsula of Baja California. See Ertter (1992) for additional biographical information on Carter.

¹⁰⁷ Walther (1892–1959), who had been inspired and mentored by Eastwood, was the Arboretum's first director. During his tenure there, he added many collections of exotics cultivated in Golden Gate Park, nurseries, and gardens throughout the state to the Academy's herbarium. Indeed, Eastwood attributed the excellent collection of ornamental plants in the herbarium primarily to his efforts (Department of Botany archives, Box 1, C.A.S. Special Collections). By 1944, Eastwood was able to boast that "our herbarium has become the chief reference for cultivated plants in the west" (Department of Botany archives, Box 1, C.A.S. Special Collections). Upon retirement, Walther took up residence in the Department of Botany and worked on a monograph of *Echeveria* (Crassulaceae) that was edited by Howell and published by the Academy in 1972 (Walther 1972).

¹⁰⁸ Construction of the four-story Wattis Hall, containing a parking garage in the basement, museum exhibits space on the ground level, the Department of Entomology on the second floor, and the Department of Botany on the third floor, was completed in 1975. The new botanical facilities were dedicated at a reception on 15 May 1976. They comprised 13,672 square feet of floor space and, with 41,942 specimen shelves, the equivalent of 1,614 standard herbarium cases. In deference to lessons learned in 1906, a walk-in and fire-proof specimen vault was constructed to house up to about 10,000 botanical type specimens. Up until this time, the botanical types had been stored in vaults only twice before, following the 1906 earthquake and fire when they were stored in the Crocker Bank vault and during World War II when they were stored in an Academy vault in the basement of Simpson African Hall (Howell 1986).

¹⁰⁹ An electronically operated compactorized storage system was installed. Because the extensive wiring

in the system was not in compliance with San Francisco's strict building codes, the wires and some other system components had to be removed and replaced with ones compliant with the codes but not designed for the electronic motors. The resulting "hybrid" system became progressively less functional to operate and more difficult and expensive to repair during the next decade. In 1989 the National Science Foundation funded a retrofit of the system to manual operation. This relieved most of the problems.

¹¹⁰ Raven's lengthy association with the Academy is discussed subsequently in the text.

¹¹¹ Published floristic studies include his checklist of the Chiapan flora in *Listados Florísticos de México IV. Flora de Chiapas* in 1986 and his introduction to and editing of the first four parts of the *Flora of Chiapas*, published by the Academy between 1981 and 1995.

¹¹² McClintock had earlier worked and received partial salary support under the auspices of an NSF-funded project (*Hortus Third*) through Cornell University (Lindsay 1968).

¹¹³ Ira L. Wiggins (1899–1987), professor of botany at Stanford University, was listed on the Academy's botanical staff as senior research botanist in 1967–1968 when he was working on the flora of the Galapagos Islands via a grant from the National Science Foundation that was administered by the Academy (Lindsay 1968); see Lindsay (1979) for biographical information on Wiggins. Wiggins's co-author on the *Flora of the Galapagos Islands*, Duncan M. Porter, was also listed as a research botanist in the Department in 1967, and he was also supported by the NSF.

¹¹⁴ For a history of the Dudley Herbarium, see Chickering (1989) or Timby (1998); for a history of biology at Stanford University, see Baumberger (1954).

¹¹⁵ Between 1946 and 1959 Day was married to Verne Grant, a well-known evolutionary biologist and student of Polemoniaceae.

¹¹⁶ Ill health eventually prevented Day from regularly coming to work at the Academy in 2005. In late 2006 she moved from the Bay Area to be cared for by family in Idaho.

¹¹⁷ The Robert Orr and Chiapan collections of macrofungi were deposited at NY in 2001 (see note 35 above).

¹¹⁸ Early curators at the Academy had scant assistance in the operation of departments and collections. Such assistance appears to have been largely on an *ad hoc* basis; prior to 1906, Hittell (1997) noted that the Academy provided some funding for an assistant (or assistants) in the herbarium from time to time. In 1896, Eastwood complained to J.N. Rose (quoted in Leviton and Aldrich 1997:364), "...I have no help and I have to do all the poisoning, checking, recording and distributing myself..." This was likely a temporary situation; various assistants in the Department during the 1890s are noted in Appendix III. Following the reopening of the Academy in Golden Gate Park in 1916, curatorial help was provided by members of the Botany Club and at various times by the institution. In her departmental report of 1928 ("Report of the Botanical Department, 1928," Department of Botany archives, Box 1, C.A.S. Special Collections) Eastwood noted that Mrs. Phelps (i.e., her sister, Kate) mounted all of the specimens, filed them in the herbarium, attended to the drying of collections, and performed various other duties. On-going, institution-funded assistance in the Department appears to have begun in the mid-1930s.

¹¹⁹ The collections manager oversees the operation of the herbarium, including supervision of curatorial assistants, herbarium records, loan and exchange programs, and collections-based projects (e.g., databasing and imaging of specimens).

¹²⁰ A floristic study of the South Mountains in the Sonoran Desert was published in *Desert Plants* (Daniel and Butterwick 1992), and a similar study of the Black Mountains in the Mohave Desert remains unpublished.

¹²¹ This publication also includes a biography of Lindsay by L.W. Mitich.

¹²² The fellowship was funded annually by Mr. and Mrs. Thomas Tilton. Mr. Tilton was a trustee, and subsequently an honorary trustee, of the Academy for many years. The fellowship was not endowed and funding for it was discontinued after Jeff Wilkinson's tenure as a Tilton Postdoctoral Fellow in the Department of Herpetology during 1997–1998.

¹²³ Smick studied Acanthaceae under Daniel. Rebecca Peters, studying Violaceae under Daniel, began her graduate studies in this program in 2001.

¹²⁴ These include (with their advisors): A. Harry, G. Lu, J. McDill, T. Morosco, L. O'Keefe, and R. Schramm (Almeda); C. Davis, Z. Deretsky, S. Franklet, B. Hall, A. Illes, H. Kho, M. Menke, N. Sammons,

M. Stalcup, and N. Strasser (Daniel); S. Lucas, C. Meldrum, J. Oppenheimer, K. Shockey (Fritsch); K. Hogan (Steiner).

¹²⁵ In 1904, William Alvord, president of the Bank of California and member of the California Botanical Club, donated \$5,000 to the Department of Botany, which then became the first research department at the Academy to have its own substantial endowment (Wilson 1955). The establishment of endowment funds, with annual usage of a portion of the earnings, has permitted specimen acquisition and research activities in the Department of Botany far in excess of what would otherwise have taken place. In addition to the three endowed curatorial chairs in botany (i.e., McAllister, Lindsay, and the yet to be filled Howell chairs), other endowed funds have been established for use by the Department. These include the Bloomer/Bryant/Hohfeld Fund for the purchase of botanical books for the library, the Lewis and Elise Rose Memorial Fund for acquisition of plant collections, the Botany Endowment Fund for special projects in botany, and several other funds for specific projects. The Rose Fund was significantly enhanced by John Rose, the son of Elise and Lewis Rose. John Rose also established a separate endowed fund at the Academy for a postdoctoral fellowship in botany.

¹²⁶ Shevock's extensive collecting activities began in 1970, and the first set of his collections is at CAS.

¹²⁷ Curators: Almeda, Daniel, Fritsch, Steiner; collections manager: Bartholomew; botanical coordinator (Madagascar): Ranarivelo; curatorial assistants: Georganne Boerger, Mona Bourell, Boni Cruz, Linda Liebelt, Stephanie Pau; secretary/receptionist: Janet Jones.

¹²⁸ There is a long tradition of volunteerism associated with the Department. Volunteers played a critical role following the destruction of the Academy in 1906. Without resources to pay technical staff, the Department relied on volunteers to help organize the incoming donations and mount specimens. Botany volunteers Ms. M.L. Campbell, Ms. G.E. Kelly, and Ms. E.P. Hawver were commended for their assistance during this period (Evermann 1916). Members of the Botany Club often provided unpaid labor in the Department during the Eastwood and Howell eras. Lewis Rose (see text) was a particularly important and effective volunteer for 30+ years during the Eastwood and Howell eras. In recent years, the Academy's volunteer services program has been a major source of volunteers for the Department. In the 14 years between 1990 and 2004, the average annual number of volunteers contributing to the work of the Department was 18.

¹²⁹ Important historical herbaria incorporated into DS include: the Harvey Herbarium (containing some 70,000 specimens, this represents one of several sets of duplicates from William Harvey of Trinity College, Dublin; it was purchased by David P. Secor and given to Stanford University in 1891; it is rich in materials from Europe, Africa, Australia, New Zealand, and from many European botanical gardens; most of these specimens date from 1750 to 1865); the herbarium of Gaston Gautier (this collection, including more than 126,000 specimens, was purchased by Herman Knoche from the Gautier heirs and given to Stanford University in 1945; it includes plants from the Mediterranean region, Asia Minor, the Balkans, North Africa, Madagascar, South Africa, and the West Indies; it includes collections of Berlandier, Boivin, Bosc, Commerson, Cuming, Dushassaing, Ecklon & Zeyher, Bombay, Forskal, Gaudichaud, Gautier, Guillemium, Kotschy, Miers, Perrottet, Schomburgk, Spruce, Verreaux, and Wallich; it also contains more than 15,000 specimens of *Hieracium* that were the basis for Arvet-Touvet's 1913 monograph of the genus); the Charles R. Orcutt Herbarium (the 15,000 or so specimens from this personal herbarium contain early collections from Baja California, southern California, and southern Mexico.); the Samuel B. Parish Herbarium (this collection of more than 30,000 specimens is rich in early collections from southern California); the herbarium of the Carnegie Institution of Washington (approximately 4,000 specimens from CI, including vouchers of studies by Clausen, Keck, Hiesey, and Nobs, were transferred to DS); and the Charles Piper Smith collection of *Lupinus* (this vast collection of North American lupines contains many types). Important major herbaria incorporated into CAS include: the Dudley Herbarium of Stanford University (containing about 750,000 specimens including all of the historical herbaria noted above, as well as collections of Stanford botanists such as Abrams, Dudley, Ferris, Raven, Thomas, and Wiggins); the Albert Prager Herbarium (the approximately 45,000 specimens purchased by the Academy in 1920 are worldwide in scope and include collections of Bêche, Boissier, Ecklon & Zeyher, Endress, Fischer & Meyer, Fleischer, Frank, Heuffel, Meyen, Prager, Schaffner, Scheele, Schimper, Schlechtendahl, Sieber, Spruner, Von Egger, and Willkom); the herbarium of Ernest Twisselmann (Twisselmann's personal herbarium of "some 20,000 specimens" was presented to the Academy in 1973 (Lindsay 1974); the first set of Twisselmann's collections from Kern County had already been deposited at the Academy); and the herbarium of

USDA Forest Service, Region 5 (this collection of 4,050 specimens, mostly from California, was transferred to CAS in 1980; the southern California branch of the Forest Service had presented its herbarium of 149 specimens (mostly *Eucalyptus*) to the Academy soon after it reopened in Golden Gate Park). Howell (1953) summarized the major collections present in the Academy's herbarium as of the middle of the twentieth century. Since that time, significant additions to the herbarium include specimens from California (e.g., Smith collections from Mendocino County, Bartholomew collections from Modoc County, Daniel and Rubtsoff collections from San Francisco County, Hoover collections from San Luis Obispo County, collections of numerous individuals from Sonoma County, Howitt and Howell collections from Monterey County, and Shevock collections from the southern Sierra Nevada), Nevada (Thiem collections), Latin America (e.g., Mexican and Central American collections of Breedlove, Almeda, and Daniel), eastern Asia (e.g., Chinese collections of Bartholomew, specimens purchased or received on exchange from several Chinese herbaria, and collections of J.F. Maxwell from Thailand), and Madagascar (e.g., collections of Almeda, Daniel, Fritsch, and de Nevers).

¹³⁰ It includes the Herman E. Hasse collection (purchased by the Academy) on which Hasse's (1913) "The Lichen Flora of Southern California" was based.

¹³¹ Sexton (1953) summarized the development and growth of the botanical library at the Academy and Eastwood's paramount role in its reestablishment following the earthquake and fire of 1906. Other than noting that it was a "great library for its time," with probably the greatest "pre-Linnaean" collection in North America, Sexton (1953:85) indicated that there was little evidence of the holdings of the library prior to 1906. However, a glimpse into its contents is recorded in a catalogue of the library published in the *Proceedings*, series 2, volume 1 in 1889, with additional accessions noted annually for several years. Jepson (1899:163) referred to botanical books in the Academy's library that relate to the flora of western North America and noted that many of these reveal that they were donations (the names of the donor in an old-fashioned hand on the inside of the cover or fly-leaf); "some of these books were the gift of Hiram G. Bloomer, and are of the kind that are now rare and difficult to obtain, including a few that deserve the name of botanical classics" (see above under Bloomer and note 26 above). British naturalist and horticultural collector Thomas Bridges noted in a letter to W.J. Hooker in 1858 that library books at the Academy included "Beechey's *Voyage*, Torrey's works, and other books" (quoted in Ewan 1955:17). Following the loss of the Academy's library in the 1906 earthquake and fire, a new set of botanical references was desperately needed for the continuance of botanical research at the institution. Eastwood's personal copies of the *Botany of the Geological Survey of California* and Asa Gray's *Synoptical Flora* had been saved in 1906 because they had been loaned to out-of-town botanists (Wilson 1955). These books, together with others donated by a variety of institutions and individuals, were the nucleus of the new botanical library at the Academy. In recognition of her contributions to botany at the Academy (e.g., establishment of an endowment fund to purchase botanical books for the library and the establishment of the Howell Chair in botany), the Board of Trustees named the Department's library, the Lillian Devendorf Hohfeld Botanical Library in 1976. The Hohfeld Library is currently located in the Department of Botany and contains primarily strictly botanical resources; interdisciplinary works that may include botanical studies are housed in the Academy's main library (i.e., J.W. Mailliard Library). In the new Academy facilities, due to open in Golden Gate Park in 2008, it is anticipated that the botanical library resources will be housed in a single, unified Academy library.

¹³² These consist of the Academy's botany reprint collection (231 linear feet), the Dudley Herbarium's reprint collection (98 linear feet), and the Adolf Engler Reprint Collection (183 linear feet). Engler's personal reprint collection was purchased from Ms. Engler, widow of the important German systematist, by Herman Knoche in 1930. The collection, consisting of some 25,000 items, was presented to the Dudley Herbarium following Knoche's death in 1945 (Chickering 1989).

¹³³ While some training in botanical science was typically a part of medical training in the nineteenth century, neither of these Academy scientists was trained as a botanist.

¹³⁴ Leviton and Aldrich (1997) listed individual and institutional donors to the Academy's library following the earthquake and fire of 1906.

¹³⁵ Eastwood and Howell had both been major collectors, but Breedlove surpassed each of them in quantity of materials gathered. With the evolution of curatorial research at the Academy away from extensive floristic work and toward focused monographic taxonomy in a phylogenetic context, it seems unlikely that

future botanical curators at the institution will surpass his collecting accomplishments.

¹³⁶ 2,731 collections of this well-known nineteenth century collector of Mexican plants were purchased by the Department (Department of Botany archives, Box 1, C.A.S. Special Collections).

¹³⁷ These are the internationally recognized abbreviations for the Dudley Herbarium of Stanford University (now housed at the Academy) and the Academy's herbarium.

¹³⁸ Kellogg, Eastwood, Howell, and McClintock never married. Eastwood had planned to marry at least twice: while in Colorado to an Eastern journalist who had come to Denver to recover from tuberculosis, but who died (which likely spurred her to accept K. Brandegee's offer to come to San Francisco as joint-curator of botany at the Academy; Wilson 1955); and later in San Francisco to her older friend, Grove Karl Gilbert, whose sudden death (Leviton et al. 2006) prevented the marriage.

¹³⁹ See note 54 above regarding the herbarium's location in the gallery of the old First Congregational Church building for some 17 years. Samuel B. Parish (1838–1928) was a rancher and an avocational botanist in southern California until he moved to Berkeley in 1920 and became an honorary curator at the herbarium of the University of California. His herbarium of more than 30,000 specimens was purchased by Stanford University in 1917 and is now at the Academy. Jepson (1932) provided an account of his life, botanical travels, and publications.

¹⁴⁰ Information about Rose is based on Howell (1953), Thomas (1961a), and various obituaries and articles in the Lewis S. Rose file in the Department of Botany "biography files."

¹⁴¹ Plants of the *Clarkia* had been previously collected by K. Brandegee and Eastwood, but had remained unnamed. Raven's recollection of them and subsequent systematic evaluations revealed them to represent a previously undescribed species (Lewis and Raven 1958).

¹⁴² The 300 elected fellows of the Academy are the ultimate governing body of the institution. In 2003, the fellows included 40 botanists (Anonymous 2003).

¹⁴³ The largest and most important collection at San Francisco State University is mycological.

¹⁴⁴ The Belvedere Scientific Fund of San Francisco was sponsored by Kenneth K. Bechtel. It supported expeditions, publications, and motion pictures on the natural history of Baja California.

¹⁴⁵ This contribution was written in 2003. Only limited updates have been made (mostly in the notes) since that time. In March 2008, the Department of Botany relocated from its interim quarters at 875 Howard Street back to Golden Gate Park and into the Academy's newly constructed museum facilities.

LITERATURE CITED

- ALDEN, R.H. AND J.D. IFFT. 1943. Early naturalists in the Far West. *Occasional Papers of the California Academy of Sciences* (20):1–59.
- ALMEDA, F. AND C.M. PRINGLE, EDS. 1988. Tropical Rainforests: Diversity and Conservation. *California Academy of Sciences Memoir* (12):1–306.
- ANONYMOUS. 1891a. Harvey Willson Harkness. *Zoe* 2:1–2.
- ANONYMOUS. 1891b. California Botanical Club. *Zoe* 2:93–96.
- ANONYMOUS. 1893. Notes and news. *Zoe* 4:196–198.
- ANONYMOUS. 1896. Miscellaneous notes and news. *Erythea* 4:37–40.
- ANONYMOUS. 1906. Biographical Review of Henry County, Iowa. Hobart Publishing Company, Chicago, Illinois, USA. 712 pp. [also available on WWW at <<http://www.rootsweb.com/~iabiog/henry/brh1906/brh1906-a.htm>>]
- ANONYMOUS. 1922. Annual Dinner for 1914 [remarks by S.B. Parish]. *Madroño* 1:71–75.
- ANONYMOUS. 1943. The Botany Department, its history and collections. *Academy Newsletter* 43:2–3.
- ANONYMOUS. 1969. Research Activities. *Annual Report of the California Academy of Sciences 1968–1969*. California Academy of Sciences, San Francisco, California, USA. 33 pp.
- ANONYMOUS. 2000. Church history. Community Congregational United Church of Christ (1305 West Second St., Benicia, California 94510) website: <<http://www.cccucc.org>>. (accessed 28 June 2006)
- ANONYMOUS. 2003. *California Academy of Sciences Annual Report 2001–2002*. California Academy of Sciences, San Francisco, California, USA. 37 pp.
- AXELROD, D.I. 1979. Age and origin of Sonoran Desert vegetation. *Occasional Papers of the California Academy of Sciences* (132):1–74.
- BAILEY HORTORIUM. 1976. *Hortus Third*. MacMillan, New York, New York, USA. 1290 pp.
- BARNHART, J.H. 1965. *Biographical Notes Upon Botanists*, vol. 1. G.K. Hall & Co., Boston, Massachusetts, USA. 563 pp.
- BAUMBERGER, J.P. 1954. A history of biology at Stanford University. *Bios* 25:123–147.
- BEHR, H.H. 1884. *Synopsis of the Genera of Vascular Plants in the Vicinity of San Francisco*. Payot, Upham & Co., San Francisco, California, USA. 165 pp.
- BEHR, H.H. 1888. *Flora of the Vicinity of San Francisco*. San Francisco, California, USA. 364 pp.
- BEHR, H.H. 1891. Botanical reminiscences. *Zoe* 2:2–6.
- BEHR, H.H. 1896. Botanical reminiscences of San Francisco. *Erythea* 4:168–173.
- BEIDLEMAN, R.G. 2006. *California's Frontier Naturalists*. University of California Press, Berkeley, California, USA. 484 pp.
- BERLIN, B., D.E. BREEDLOVE AND P.H. RAVEN. 1974. *Principles of Tzeltal Plant Classification: An Introduction to the Botanical Ethnography of a Mayan-Speaking People of Highland Chiapas*. Academic Press, New York, New York, USA. 660 pp.
- BEST, C., J.T. HOWELL, W. KNIGHT, I. KNIGHT, AND M. WELLS. 1996. *A Flora of Sonoma County: Manual of the Flowering Plants and Ferns of Sonoma County, California*. California Native Plant Society, Sacramento, California, USA. 347 pp.
- BLOOMER, H.G. 1868. On the scientific name of the "Big Trees." *Proceedings of the California Academy of Natural Sciences* 3:399–401.
- BOLANDER, H.N. 1870. *A Catalogue of the Plants Growing in the Vicinity of San Francisco*. A. Roman and Co., San Francisco, California, USA. 43 pp.
- BONTA, M. 1983. Alice Eastwood. *American Horticulturist* 62(10):10–15.
- BONTA, M.M. 1991. *Women in the Field: America's Pioneering Women Naturalists*. Texas A&M University Press, College Station, Texas, USA. 299 pp.
- BOSQUI, E. 1952. *Memoirs*. Holmes Book Co., Oakland, California, USA. 180 pp.
- BRANDEGEE, K. 1892a. Catalogue of the flowering plants and ferns growing spontaneously in the city of San Francisco. *Zoe* 2:334–386.
- BRANDEGEE, K. 1892b. Additions to the catalogue of San Francisco plants. *Zoe* 3:49–50.
- BRANDEGEE, K. 1893a. Dr. Albert Kellogg. *Zoe* 4:1–2.

- BRANDEGEE, K. 1893b. The botanical writings of Edward L. Greene. *Zoe* 4:63–103.
- BRANDEGEE, K. 1894. [Review of] *Manual of the Bay Region Botany, A Systematic Arrangement of the Higher Plants Growing Spontaneously in the Counties of Marin, Sonoma, Napa, Solano, Contra Costa, Alameda, Santa Clara, San Mateo, and San Francisco*. By Edward Lee Greene. *Zoe* 4:417–420.
- BREEDLOVE, D.E. AND R.M. LAUGHLIN. 1993. The flowering of man: a Tzotzil botany of Zinacantán. *Smithsonian Contributions to Anthropology* 35(1–2):1–706.
- BREWER, W.H. 1880. List of persons who have made botanical collections in California. Pages 553–559 in S. Watson, *Botany [of California]*, vol. 2. John Wilson and Son, University Press, Cambridge, Massachusetts, USA. 559 pp.
- BUECHNER, H.K. AND F.R. FOSBERG. 1967. A contribution toward a world program in tropical biology. *BioScience* 17:532–538.
- CARLQUIST, S. 1997. Peter H. Raven—recipient of the 1996 Asa Gray Award. *Systematic Botany* 22:1–3.
- CHICKERING, S. 1989. Growing herbaria at the California Academy of Sciences. *Fremontia* 17(1):3–10.
- CONMY, P.T. 1958. A botanist tends his plants. *CTA Journal* 54(4):20–21, 27.
- CONSTANCE, L. 1978. *Botany at Berkeley: The First Hundred Years*. Department of Botany, University of California, Berkeley, California, USA. 21 pp.
- CROSSWHITE, F.S. 1979. “J.G. Lemmon & Wife,” plant explorers in Arizona, California, and Nevada. *Desert Plants* 1:12–21.
- CROSSWHITE, F.S. AND C.D. CROSSWHITE. 1985. The plant collecting Brandegees, with emphasis on Katharine Brandegee as a liberated woman scientist of early California. *Desert Plants* 7:128–139, 158–162.
- CURRAN, M.K. 1885. List of the plants described in California, principally in the Proc. of the Cal. Acad. of Sciences, by Dr. Albert Kellogg, Dr. H.H. Behr, and Mr. H.N. Bolander; with an attempt at their identification. *Bulletin of the California Academy of Sciences* 1:128–151.
- DAKIN, S.B. 1954. *The Perennial Adventure, A Tribute to Alice Eastwood*. California Academy of Sciences, San Francisco, California, USA. 50 pp.
- DANIEL, T.F. 1997. The Acanthaceae of California and the peninsula of Baja California. *Proceedings of the California Academy of Sciences* 49:309–403.
- DANIEL, T.F. AND M.L. BUTTERWICK. 1992. Flora of the South Mountains of south-central Arizona. *Desert Plants* 10:99–119.
- DANIEL, T.F., F. ALMEDA, AND D.E. BREEDLOVE. 1994. John Thomas Howell, 1903–1994. *Madroño* 41:234–235.
- DAVIDSON, G. 1889. Sketch of the life and work of Dr. Kellogg. Pages v–vii in E.L. Greene, *Illustrations of West American Oaks from Drawings by the Late Albert Kellogg, M.D.* Privately printed, San Francisco, California, USA. 84 pp.
- DUNCAN, T. 2006. Eastwood in exile. *California Wild* 59(2):22–25, 34.
- DUPREE, A.H. 1959. *Asa Gray*. Harvard University Press, Cambridge, Massachusetts, USA. 505 pp.
- EASTWOOD, A. Undated. *The Flora of the Nob Hill Cobbblestones, San Francisco in the 1890's*. California Botanical Club, San Francisco, California, USA. 8 pp.
- EASTWOOD, A. 1905. A handbook of the trees of California. *Occasional Papers of the California Academy of Sciences* (9):1–86.
- EASTWOOD, A. 1941. On the golden anniversary of the California Botanical Club. *Leaflets of Western Botany* 3:26–27.
- EASTWOOD, A. 1952. The Albert Prager herbarium of the California Academy of Sciences. *Leaflets of Western Botany*. 6:205–207.
- EISEN, G. 1901. The fig: its history, culture, and curing, with a descriptive catalogue of the known varieties of figs. *United States Department of Agriculture Bulletin* 9:1–317.
- ERTTER, B. 1992. Annetta Mary Carter (1907–1991). *Madroño* 39:245–250.
- ERTTER, B. 2000. People, plants, and politics: the development of institution-based botany in California 1853–1906. Pages 203–248 in M.T. Ghiselin and A.E. Leviton, eds., *Cultures and Institutions of Natural History. Memoirs of the California Academy of Sciences* (25):1–363.
- ESTABROOK, J.D. 1908. *Three generations of Northboro Davises 1781 – 1894*. The Chronotype Printing Company, Westboro, Massachusetts, USA. 84 pp.

- EVERMANN, B.W. 1916. Report of the director of the museum for the year 1915. *Proceedings of the California Academy of Sciences*, ser. 4, 5:203–223.
- EWAN, J. 1942. Bibliographical miscellany—IV. A bibliogeographical guide to the Brandegee botanical collections. *American Midland Naturalist* 27:772–789.
- EWAN, J. 1950. *Rocky Mountain Naturalists*. University of Denver Press, Denver, Colorado, USA. 358 pp.
- EWAN, J. 1953. Botany at the Academy in the city of the Golden Fifties. *Leaflets of Western Botany* 7:43–57.
- EWAN, J. 1955. San Francisco as a Mecca for nineteenth century naturalists. Pages 1–63 in *A Century of Progress in the Natural Sciences 1853–1953*. California Academy of Sciences, San Francisco, California, USA. 807 pp.
- EWAN, J. 1973. William Lobb, plant hunter for Veitch and messenger of the big tree. *University of California Publications in Botany* 67:1–36.
- FARQUHAR, F.P., ED. 1930. *Up and Down California in 1860–1864: the Journal of William H. Brewer*. Yale University Press, New Haven, Connecticut, USA. 601 pp.
- FULLER, T.C. AND E. MCCLINTOCK. 1986. *Poisonous Plants of California*. University of California Press, Berkeley, California, USA. 433 pp.
- GAMBILL, W.G. 1988. The story of Miss Alice Eastwood. *The Green Thumb* 42(2):53–72.
- GENTRY, H.S. 1978. The Agaves of Baja California. *Occasional Papers of the California Academy of Sciences* (130):1–119.
- GILLET, G.W., J.T. HOWELL, AND H. LESCHKE. 1961. *A Flora of Lassen Volcanic National Park, California*. University of San Francisco, San Francisco, California, USA. 185 pp.
- GREENE, E.L. 1887. Biographical notice of Dr. Albert Kellogg. *Pittonia* 1:145–151.
- GREENE, E.L. 1889. *Illustrations of West American Oaks from Drawings by the Late Albert Kellogg, M.D.* Privately printed, San Francisco, California, USA. 84 pp.
- GREENE, E.L. 1894. *Manual of the Botany of the Region of San Francisco Bay. Being a Systematic Arrangement of the Higher Plants Growing Spontaneously in the Counties of Marin, Sonoma, Napa, Solano, Contra Costa, Alameda, Santa Clara, San Mateo and San Francisco in the State of California*. Cubery & Company, San Francisco, California, USA. 328 pp.
- GREENE, M.A. 1981. He catalogued Cayuga's flora. *Cornell Countryman* 79(1):11.
- GROPP, R.E. 2003. Are university natural science collections going extinct? *BioScience* 53:550.
- GRUNSKY, C.E. 1914. Report of the president of the Academy for the year 1913. *Proceedings of the California Academy of Sciences*, ser. 4, 4:1–13.
- GUTZKOW, F., G. CHISHMORE, AND A. EASTWOOD. 1905. *Doctor Hans Herman Behr*. California Academy of Sciences, San Francisco, California, USA. 7 pp.
- HARKNESS, H.W. AND J.P. MOORE. 1880. *Catalogue of the Pacific Coast Fungi*. California Academy of Sciences, San Francisco, California, USA. 46 pp.
- HASSE, H.E. 1913. The lichen flora of southern California. *Contributions from the United States National Herbarium* 17:1–132.
- HERRE, A.W.C.T. 1960. *Katherine [sic] Brandegee: a reply to a fantasy by J. Ewan*. Printed and distributed by the author. Unpaginated.
- HICKMAN, J.C., ED. 1993. *The Jepson Manual: Higher Plants of California*. University of California Press, Berkeley, California, USA. 1400 pp.
- HITTELL, T.H. 1997. A narrative history of the California Academy of Sciences, 1853–1906, pages 11–484 in A.E. Leviton and M.L. Aldrich, eds., Theodore Henry Hittell's *The California Academy of Sciences a Narrative History: 1853–1906. Memoirs of the California Academy of Sciences* (22):i–xv + 1–623 pp.
- HOWELL, J.T. 1929. A systematic study of the genus *Lessingia* Cham. *University of California Publications in Botany* 16(1):1–44.
- HOWELL, J.T. 1949. *Marin Flora, Manual of the Flowering Plants and Ferns of Marin County, California*. University of California Press, Berkeley, California, USA. 322 pp.
- HOWELL, J.T. 1953. The botanical collections of the California Academy of Sciences. *Leaflets of Western Botany* 7:89–99.
- HOWELL, J.T. 1954a. Alice Eastwood, 1859–1953. *Sierra Club Bulletin* 39(6):78–80.
- HOWELL, J.T. 1954b. Alice Eastwood, 1859–1953. *Taxon* 3:98–100.

- HOWELL, J.T. 1967. John Thomas Howell: Autobiographical Notes of Botanical Interest. Unpublished typescript in Howell files of Department of Botany "biography files."
- HOWELL, J.T. 1986. Historical Recollections of John Thomas Howell Regarding Alice B. Chittenden. Unpublished typescript in Chittenden files of Department of Botany "biography files."
- HOWELL, J.T. AND P. ELLMAN. 1972. *Saint Hilary's Garden: a Flora of Old St. Hilary's Historic Preserve*. Landmarks Society, Belvedere-Tiburon, California, USA. 44 pp.
- HOWELL, J.T., P.H. RAVEN, AND P. RUBTZOFF. 1958. *A Flora of San Francisco, California*. University of San Francisco, San Francisco, California, USA. 157 pp.
- HOWITT, B.F. AND J.T. HOWELL. 1964. *The Vascular Plants of Monterey County, California*. University of San Francisco, San Francisco, California, USA. 184 pp.
- JEPSON, W.L. 1897. Biographical sketch of Dr. W.P. Gibbons. *Erythea* 5:74–76.
- JEPSON, W.L. 1898. Dr. Henry N. Bolander, Botanical Explorer. *Erythea* 6:100–107.
- JEPSON, W.L. 1899. Biographical sketch of H.G. Bloomer. *Erythea* 7:163–166.
- JEPSON, W.L. 1928. The botanical explorers of California.—I. *Madroño* 1:167–170.
- JEPSON, W.L. 1932. Samuel Bonsall Parish. *University of California Publications in Botany* 16:427–444.
- JEPSON, W.L. 1933. The botanical explorers of California.—VIII. *Madroño* 2:83–88.
- JEPSON, W.L. 1934. The botanical explorers of California.—IX. *Madroño* 2:115–118.
- JONES, M.E. 1929. The Brandegees. *Contributions to Western Botany* 15:15–18.
- JONES, M.E. 1930. C.C. Parry. *Contributions to Western Botany* 17:3–6.
- JONES, M.E. 1933. Mrs. T.S. Brandegee. *Contributions to Western Botany* 18:12–18.
- JORDAN, D.S. 1911. William Russel Dudley. *Science* 34:142–145.
- KEARNEY, T.H. 1958. Botanists I have known. *Leaflets of Western Botany* 8:275–280.
- KEARNEY, T.H. AND R.H. PEEBLES. 1942. *Flowering Plants and Ferns of Arizona*. United States Department of Agriculture Miscellaneous Publication 423. Washington, D.C., USA. 1069 pp.
- KEARNEY, T.H., R.H. PEEBLES, AND COLLABORATORS. 1951. *Arizona Flora*. University of California Press, Berkeley, California, USA. 1032 pp.
- KELLOGG, A. 1882. Forest trees of California. Appendix, pages 3–116 in H.G. Hanks, *Second Report of the State Mineralogist of California*. State Office, Sacramento, California, USA. 226 pp.
- KISTLER, E.D. 1936. Bibliography of the botanical writings of Edward Lee Greene. *Madroño* 3:328–348.
- KNIGHT, W., I. KNIGHT, AND J.T. HOWELL. 1970. A vegetation survey of the Butterfly Botanical Area, California. *The Wasmann Journal of Biology* 28:1–46.
- LAMMERS, T. 1999. Plant systematics today: all our eggs in one basket? *Systematic Botany* 24:494–496.
- LEGGE, R.T. 1953. Hans Herman Behr: German doctor, California professor and academician, and "Bohemian." *California Historical Society Quarterly* 32:243–262.
- LENZ, L.W. 1986. *Marcus E. Jones: Western Geologist, Mining Engineer & Botanist*. Rancho Santa Ana Botanic Garden, Claremont, California, USA. 486 pp.
- LEVITON, A.E. AND M.L. ALDRICH, EDS. 1997. *Theodore Henry Hitell's the California Academy of Sciences: a Narrative History, 1853–1906. Memoirs of the California Academy of Sciences* (22):i–xv + 1–623 pp.
- LEVITON, A.E., M.L. ALDRICH, AND K. ELSBERND. 2006. The California Academy of Sciences, Grove Karl Gilbert, and photographs of the 1906 earthquake, mostly from the archives of the Academy. *Proceedings of the California Academy of Sciences*, ser. 4, 57(1):1–34.
- LEWIS, H. AND P. RAVEN. 1958. *Clarkia franciscana*, a new species from central California. *Brittonia* 10:7–13. 1958
- LINDSAY, G. 1968. Resumé history of the Department of Botany, California Academy of Sciences. Unpublished typescript in Lindsay files of Department of Botany "biography files."
- LINDSAY, G. 1974. Report of the director. Pages 4–14 in *California Academy of Sciences Annual Report 1972–73*. California Academy of Sciences, San Francisco, California, USA. 25 pp.
- LINDSAY, G. 1979. Ira Loren Wiggins, naturalist. *Pacific Discovery* 32:1–9.
- LINDSAY, G. 1983. History of scientific exploration in the Sea of Cortéz. Pages 3–12 in T.J. Case and M.L. Cody (eds.), *Island Biogeography in the Sea of Cortéz*. University of California Press, Berkeley, California, USA. 508 pp.
- LINDSAY, G. 1996. *The taxonomy and ecology of the genus Ferocactus, explorations in the USA and Mexico*.

- Tireless Termites Press, USA. 444 pp.
- LINSDALE, M.A., J.T. HOWELL, AND J.M. LINSDALE. 1952. Plants of the Toiyabe Mountains area, Nevada. *The Wasmann Journal of Biology* 10:129–200.
- LOTT, E.J. 1993. Annotated checklist of the vascular flora of the Chamela Bay region, Jalisco, Mexico. *Occasional Papers of the California Academy of Sciences* (148):1–60.
- MATHIAS, M.E. AND E. MCCLINTOCK. 1963. *A Checklist of Woody Ornamental Plants of California*. California Agricultural Experiment Station Extension Service, Manual 32. University of California College of Agriculture, Berkeley, California, USA. 65 pp.
- MACFARLAND, F.M., R.C. MILLER, AND J.T. HOWELL. 1949. Biographical sketch of Alice Eastwood. *Proceedings of the California Academy of Sciences*, ser. 4, 25:IX–XIV.
- MACFARLANE, F.M. AND V.J. SEXTON. 1949. Bibliography of the writings of Alice Eastwood. *Proceedings of the California Academy of Sciences*, ser. 4, 25:XV–XXIV.
- MCCLINTOCK, E. 1957. A monograph of the genus *Hydrangea*. *Proceedings of the California Academy of Sciences* 29:147–256.
- MCCLINTOCK, E. 1977. *The Japanese Tea Garden, Golden Gate Park, San Francisco, California*. The John McLaren Society, San Francisco, California, USA. 45 pp.
- MCCLINTOCK, E. 2001. *The Trees of Golden Gate Park and San Francisco*. Pacific Horticultural Foundation, Berkeley, California, USA. 244 pp.
- MCCLINTOCK, E. AND A.T. LEISER. 1979. *An Annotated Checklist of Woody Ornamental Plants of California, Oregon, & Washington*. Division of Agricultural Sciences, University of California, Berkeley, California, USA. 134 pp.
- MCCLINTOCK, E. AND V. MOORE. 1965. *Trees of the Panhandle, Golden Gate Park, San Francisco*. California Academy of Sciences Miscellaneous Paper No. 1. 56 pp.
- MCCLINTOCK, E., W. KNIGHT, AND N. FAHY. 1968. A flora of the San Bruno Mountains San Mateo County, California. *Proceedings of the California Academy of Sciences*, ser. 4, 32:587–677.
- MCCLINTOCK, E., P. REEBERG, AND W. KNIGHT. 1990. *A Flora of the San Bruno Mountains*. California Native Plant Society, Sacramento, California, USA. 223 pp.
- MCCLINTOCK, E., M.E. MATHIAS, AND H. LEWIS, EDS. 1982. *An Annotated Checklist of Ornamental Plants of Coastal Southern California; Based on Plants Exhibited and Discussed at the Southern California Horticultural Institute*. Division of Agricultural Sciences, University of California, Berkeley, California, USA. 162 pp.
- MCINTOSH, R.P. 1983. Edward Lee Greene: the man. Pages 18–53 in F.N. Egerton, ed., *Landmarks of Botanical History: Edward Lee Greene*, Part 1. Hunt Institute for Botanical Documentation, Stanford University Press, Stanford, California, USA. 505 pp.
- McKELVEY, S.D. 1955. *Botanical Exploration of the Trans-Mississippi West, 1790–1850*. Arnold Arboretum of Harvard University, Jamaica Plain, Massachusetts, USA. 1144 pp.
- McVAUGH, R. 1983. Edward Lee Greene: an appraisal of his contribution to botany. Pages 54–84 in F.N. Egerton (ed.), *Landmarks of Botanical History: Edward Lee Greene*, Part 1. Hunt Institute for Botanical Documentation, Stanford University Press, Stanford, California, USA. 505 pp.
- MILLER, R.C. 1942. The California Academy of Sciences and the early history of science in the West. *California Historical Society Quarterly* 21:363–371.
- MILLER, R.C. 1949. Report of the director. Pages 9–17 in *Annual Report for the Year 1949*. California Academy of Sciences, San Francisco, California, USA. 27 pp.
- MILLER, R.C. 1958. *Annual Report for the Year Ending June 30, 1958 with a Condensed Report for the Years Since 1949*. California Academy of Sciences, San Francisco, California, USA. 48 pp.
- MILLER, R.C. 1960. Report. Pages 7–25 in *Annual Report 1960*. California Academy of Sciences, San Francisco, California, USA. 46 pp.
- MORAN, R. 1952. The Mexican itineraries of T.S. Brandegees. *Madroño* 11:253–262.
- MORAN, R. 1996. The Flora of Guadalupe Island, Mexico. *Memoirs of the California Academy of Sciences* (19):1–190.
- MUNZ, P.Z. 1953. A century of achievement. *Leaflets of Western Botany* 7:69–78.
- O'BRIEN, R. 1947. "The Story of the Academy of Sciences." Riptides Column in *San Francisco Chronicle* of

5 May 1947.

- PEATTIE, D.C. 1953. *A Natural History of Western Trees*. Houghton Mifflin, Boston, Massachusetts, USA. 751 pp.
- PEÑALOSA, J. 1963. A flora of the Tiburon Peninsula, Marin County, California. *The Wasmann Journal of Biology* 21:1–74.
- POLLARD, H.N. 1959. A plant list from Santa Barbara, California. *The Wasmann Journal of Biology* 17:153–156.
- RAVEN, P.H. 1956. What the Student Section Has Done for Me. Unpublished typescript in Raven files of Department of Botany “biography files.”
- RAVEN, P.H. 1988. Tropical floristics tomorrow. *Taxon* 37:549–560.
- REGIONAL ORAL HISTORY OFFICE. 1987. *California Women in Botany*. Interviews conducted by Carol Holleuffer in 1985. Bancroft Library, University of California, Berkeley, California, USA. ca. 200 pp.
- REITTER, V. 1953. Horticulture and the California Academy of Sciences. *Leaflets of Western Botany* 7:79–84.
- RICHARDSON, H. 1970. A botanist named Bloomer. *Pacific Discovery* 23(2):28–32.
- RUBTZOFF, P. 1953. A phytogeographical analysis of the Pitkin Marsh. *The Wasmann Journal of Biology* 11:129–219.
- RUSH, E. 2003. Hardy perennial, Alice Eastwood reinvigorates the Academy. *California Wild* 56(2):22–26.
- SETCHELL, W.A. 1926. Townshend Stith Brandegee and Mary Katharine (Layne) (Curran) Brandegee. *University of California Publications in Botany* 13(8):155–178.
- SEWELL, J.S. 1907. The effects of the earthquake and fire on buildings, engineering structures, and structural materials. *U.S. Geological Survey Bulletin* (324):62–130.
- SEXTON, V. 1953. Books and botany. *Leaflets of Western Botany* 7:85–88.
- SMITH, G.L. 1973. A flora of the Tahoe Basin and neighboring areas. *The Wasmann Journal of Biology* 31:1–231. [reprinted in 1984 with supplement as *A Flora of the Tahoe Basin and Neighboring Areas and Supplement*. University of San Francisco, San Francisco, California, USA. 231 pp. + supplement of 46 pp.]
- SMITH, G.L. 1989. John Thomas Howell: peripatetic botanist. *Fremontia* 17:11–19.
- SMITH, G.L. AND C.R. WHEELER. 1992 [“1990–1991”]. A flora of the vascular plants of Mendocino County, California. *The Wasmann Journal of Biology* 48/49 (1–2):1–387.
- SOHMER, S.H. 1980. NSF support of basic research in tropical biology. *BioScience* 30:412–415.
- STARR, E.C. 1926. *A History of Cornwall, Connecticut, a Typical New England Town*. Tuttle, Morehouse & Taylor Co., New Haven, Connecticut, USA. 547 pp.
- STEARNS, R.E.C. 1908. Dr. John B. Trask, a pioneer of science on the West Coast. *Science* 28:240–243.
- STEPHENS, L.D. 1982. *Joseph Le Conte: Gentle Prophet of Evolution*. Louisiana State University Press, Baton Rouge, Louisiana, USA. 340 pp.
- STEWART, A. 1911. Expedition of the California Academy of Sciences to the Galapagos Islands, 1905–1906. II. A botanical survey of the Galapagos Islands. *Proceedings of the California Academy of Sciences*, ser. 4, 1:7–288.
- STEWART, A. 1912a. Expedition of the California Academy of Sciences to the Galapagos Islands, 1905–1906. V. Notes on the botany of Cocos Island. *Proceedings of the California Academy of Sciences*, ser. 4, 1:375–404.
- STEWART, A. 1912b. Expedition of the California Academy of Sciences to the Galapagos Islands, 1905–1906. VII. Notes on the lichens of the Galapagos Islands. *Proceedings of the California Academy of Sciences*, ser. 4, 1:431–446.
- THOMAS, J.H. 1961a. The history of botanical collecting in the Santa Cruz Mountains of central California. *Contributions from the Dudley Herbarium* 5:147–168.
- THOMAS, J.H. 1961b. *Flora of the Santa Cruz Mountains of California*. Stanford University Press, Stanford, California, USA. 434 pp.
- THOMAS, J.H. 1969. Botanical explorations in Washington, Oregon, California and adjacent regions. *Huntia* 3:5–62.
- TIMBY, S. 1998. The Dudley Herbarium. *Sandstone and Tile* 22(4):3–15.
- TRUE, G.H. 2003. The ferns and seed plants of Nevada County, California. *The Four Seasons* 12:12–69.
- TURNER, R.G. 1997. A salute to Elizabeth. *Pacific Horticulture* 58:1–2.

- TWISSELMANN, E.C. 1956. A flora of the Temblor Range and the neighboring part of the San Joaquin Valley. *The Wasmann Journal of Biology* 14:161–300.
- TWISSELMANN, E.C. 1967. A Flora of Kern County, California. *The Wasmann Journal of Biology* 25:1–395.
- WALTHER, E. 1972. *Echeveria*. California Academy of Sciences, San Francisco, California, USA. 426 pp.
- WALTHER, E. AND E. MCCLINTOCK. 1958. *Guide List to Plants in the Strybing Arboretum*. Strybing Arboretum Society, San Francisco, California, USA. 76 pp.
- WIGGINS, I.L. 1952. T.H. Kearney. *Pacific Discovery* 5(2):28–29.
- WIGGINS, I.L. AND J.H. THOMAS. 1962. *A Flora of the Alaskan Arctic Slope*. University of Toronto Press, Toronto, Canada. 425 pp.
- WILLIAMS, M.J., J.T. HOWELL, G.H. TRUE, JR., AND A. TIEHM. 1992. A catalogue of vascular plants on Peavine Mountain. *Mentzelia* 6(2):3–84.
- WILSON, C.G. 1953. A partial gazetteer and chronology of Alice Eastwood's botanical explorations. *Leaflets of Western Botany* 7:65–68.
- WILSON, C.G. 1955. *Alice Eastwood's Wonderland, the Adventures of a Botanist*. California Academy of Sciences, San Francisco, California, USA. 222 pp.

APPENDIX I. Botanical curators by year. Information herein has been derived from Hittell (1997), files in the Academy's Archives (which are based on data from Trustees Minutes and Council Minutes), and the *Proceedings of the California Academy of Sciences*. For years in which no botanical curator is indicated by these sources, "unknown" is stated.

| | |
|---|--|
| 1853–54 Kellogg | 1888–89 Curran, Davis |
| 1855 Andrews (until 2 April), Behr (from 2 April) | 1890 K. Brandegee, Rattan |
| 1856 Bloomer | 1891–92 K. Brandegee |
| 1857 unknown | 1893 K. Brandegee, Eastwood |
| 1858–62 Bloomer | 1894 Dudley, Eastwood |
| 1863–64 Kellogg | 1895 Eastwood |
| 1865–67 Bolander | 1896 Eastwood, Harkness (curator of fungi) |
| 1868 Bloomer | 1897–1930 Eastwood |
| 1869 unknown | 1931–48 Eastwood, Howell |
| 1870 unknown | 1949–68 Howell, McClintock |
| 1871–72 Bolander | 1969–74 Breedlove, McClintock, Thomas |
| 1873 unknown | 1975 Breedlove, Day, McClintock, Thomas |
| 1874 unknown | 1976 Breedlove, Day, Earle (curator of phycology),
McClintock, Thomas |
| 1875 Bolander | 1977 Breedlove, Day, Earle (curator of phycology),
McClintock, Thomas |
| 1876 Kellogg | 1978–85 Almeda, Breedlove, Day, Earle (curator of
phycology), Thomas |
| 1877 unknown | 1986–94 Almeda, Breedlove, Daniel, Thomas |
| 1878 unknown | 1995 Almeda, Daniel, Thomas |
| 1879 Kellogg | 1996–97 Almeda, Daniel, Fritsch, Thomas |
| 1880 unknown | 1998–99 Almeda, Daniel, Fritsch |
| 1881 Kellogg | 2000–03 Almeda, Daniel, Fritsch, Steiner |
| 1882 Moore | |
| 1883 Curran, Moore | |
| 1884–87 Curran, Greene | |

APPENDIX II. Departmental Associates. Throughout its history, the Academy's Department of Botany has served as the botanical headquarters for numerous amateur and professional botanists who were not on its payroll but active in collections-based research. The California Botanical Club and many of its mostly avocational botanists were headquartered in the Department since the Club's founding in 1891. Those persons formally accorded the title of Associate (including Field Associates and Research Associates), and often whose primary place of botanical work was at the Academy, are listed below along with their botanical interests while at the Academy.

| | |
|---|--|
| Barrett Anderson (Lamiaceae, flora of California) | Reid Moran (flora of Baja California and Guadalupe Island, Crassulaceae) |
| Catherine Best (flora of Sonoma County) | Daniel Norris (bryophytes) |
| Guido J. Braem (Orchidaceae) | Robert Ornduff (pollination systems) |
| Mary L. Butterwick (flora of Arizona, Cucurbitaceae) | Robert W. Patterson (Polemoniaceae) |
| Alva Day (Polemoniaceae) | Henry M. Pollard (flora of Ventura and Santa Barbara counties) |
| Greg de Nevers (Arecaceae, flora of Pepperwood Reserve) | Peter H. Raven (student collector; Flora of San Francisco) |
| Barbara Ertter (flora of California, Rosaceae) | Orbelia Robinson (Melastomataceae) |
| Wilma Follette (flora of Marin County) | Lewis S. Rose (plants of California) |
| Thomas C. Fuller (weeds and poisonous plants of California) | Peter Rubtsoff (flora of San Francisco; flora of San Bruno Mountain) |
| Nir L. Gil-ad (Violaceae) | James R. Shevock (California flora, bryophytes) |
| Clare B. Hardham (Lamiaceae, flora of San Luis Obispo County) | Gladys L. Smith (flora of Mendocino County) |
| Robert F. Hoover (flora of San Luis Obispo County) | John W. Stacey (Carex in western North America) |
| Beatrice F. Howitt (flora of Monterey County) | Susan G. Stokes (Eriogonum) |
| James D. Jakerst (flora of California) | John L. Strother (Asteraceae) |
| Thomas L. Kearney (flora of Arizona, Malvaceae) | Dorothy Sutcliffe (Hepaticae, flora of California) |
| Barbara Keller (cultivated plants) | David Toren (bryophytes) |
| Walter Knight (flora of Sonoma County) | Gordon H. True (flora of Nevada County) |
| Irja Knight (flora of Sonoma County) | Ernest C. Twisselmann (flora of Kern County) |
| Hans Leschke (Carex) | Mary P. Wells (flora of Sonoma County) |
| Roger Macfarlane (Liliaceae) | Ira L. Wiggins (plants of northwestern Mexico and Galapagos Islands) |
| DeAda Mally (Orchidaceae) | |
| William A. McNamara (flora of Asia) | |

APPENDIX III. Departmental support staff and postdoctoral fellows. The following individuals are known to have been employed by the Academy in the Department of Botany through 2003. The dates given reflect those noted by Hittell (1997), in the Academy's published annual reports (where available), and in the Department's unpublished annual reports (where available). Until 1950, annual reports were based on calendar years; beginning 1 July 1951, annual reports were based on fiscal years ending on 30 June. As a result, some dates indicated below do not necessarily reflect hiring dates (which may have been in the calendar year previous to that indicated). While the readily available records are extensive, they are not complete. Numerous illustrators/artists have worked in the Department for various projects, usually on a contract basis for individual curators. Since 1985, these have included: T. Bell, M. Butterwick, T. Cash, E. del Valle, M. Fylling, S. Guthrie, J. Kane, N. King, P. Hayes, D. Louie, S. (Hill) Myers, H. Pazdírková, C. Rendu, V. Saxe, J. Speckels, C. Sudekum, and M. Tenorio. Interns in botanical illustration through the Academy's Fellows Illustration Intern program are listed in the text.

- Joy Albright-Souza, Curatorial Assistant (1994–96, 2000), Senior Curatorial Assistant (2001)
 Barrett Anderson, Research Assistant (1986–88)
 Luis Baptista, Herbarium Assistant (1966)
 Bruce Bartholomew, Collections Manager (1983–90), Senior Collections Manager (1991–)
 Nova Bevel, Curatorial Assistant (1971)
 Isabel Boardman, Typist (S.E.R.A.) (19??)
 Charles Boatman, Curatorial Assistant (1971–72)
 Brita Boeckel, Assistant (1957–60, 1964)
 Lee Boerger, Curatorial Assistant (1988–)
 Mona Bourell, Curatorial Assistant (1982–85), Senior Curatorial Assistant (1986–)
 Mrs. H.P. Bracelin, Assistant (1935–36, 1940–43)
 Marie Buffam, Typist (W.P.A.) (1938)
 Marian L. Campbell, Assistant (1917–1921)
 Sheila Campion, Secretary (1972)
 Evelina Cannon, Assistant (1895–?, 1899–1901)
 Doris Cantou, Assistant (1964–65), Bibliographer (1966)
 Blanche Clear, Assistant (1938–40, 1958–68)
 Anne Clemons, Assistant (S.E.R.A.) (19??)
 Mary Jo Cobb, Assistant (1948–50, 1953)
 Steven Corso, Curatorial Assistant (2000)
 Boni Cruz, Senior Curatorial Assistant (2002–)
 Mary Davis, Curatorial Assistant (1971)
 Evelyn Deasy, Typist (1945, 1948–52)
 Adele Doss, Typist (1952)
 Dorothy Duff, Assistant (1917)
 Charles Durege, Curatorial Assistant (1971–72)
 Alice Eastwood, Assistant (1892)
 Claire Etienne, Curatorial Assistant (1969–74)
 Georgia Fitzsimmons, Assistant (1945)
 Stina Freitas, Curatorial Assistant (1993–94)
 Rosalie Farish, Assistant (1896)
 Evelyn Graham, Assistant (1937)
 Virginia Gregory, Secretary (1976–78)
 Betty Hammerly, Assistant (1941–42)
 Suzanne Harmon, Curatorial Assistant (2001–02)
 John T. Hicks, Curatorial Assistant (1974)
 Robert F. Hoover, Assistant (1948)
 Nancy Horsman, Scientific Assistant (1981)
 John T. Howell, Assistant (1930)
 Sharon Hue, Curatorial Assistant (1971–72)
 Zoe Irving, Curatorial Assistant (1971)
 Carolyn Jones, Typist (1956–57)
 Janet Jones, Secretary (1979–1998), Senior Secretary (1998–)
 Mary E. Jump, Assistant (1939)
 Saichi Kawahara, Curatorial Assistant (1969, 1971)
 Barbara Keller, Curatorial Assistant (1975–77), Senior Curatorial Assistant (1978–86)
 Walter Knight, Assistant (1965)
 Leslie Landrum, Tilton Postdoctoral Fellow (1983–1984), Research Assistant (1986)
 Sonia Landrum, Secretarial Assistant (1984–86)
 May Larsen, Assistant (1947–48)
 Joan Leong, Preparator (1985)
 Linda Liebelt, Curatorial Assistant (1991–)
 Carole Litwin, Curatorial Assistant (2000)
 Gabriel Mascardo, Computer Specialist (1993–95)
 Yvonne Mason, Curatorial Assistant (1972)
 Elizabeth McClintock, Research Assistant (1948–49)
 Effie A. McIlriach, Assistant (1893–1895?)*
 Kenneth Miller, Curatorial Assistant (1971–72)
 Virginia Moore, Technical Assistant (1964–68), Senior Curatorial Assistant (1969), Curatorial Assistant (1970–71)
 Jude Mullé, Curatorial Assistant (1997)
 Judy Murray, Curatorial Assistant (1969)
 Gwendolen O. Newell, Assistant (1899–1906).
 Anita Noldeke, Assistant (1958–68), Curatorial Assis-

- tant (1969–81), Preparator (1982)
 Sally Norwall, Assistant (1958–68)
 Olga Padgett, Assistant (1948–61)
 Stephanie Pau (2001–03)
 Javier Peñalosa, Assistant (1961)
 Ana Maria Penny, Curatorial Assistant (1988–90)
 Kate E. Phelps, Assistant (1919–1948)**
 Peter Raven, Assistant (1949–56)
 Jane Reese, Technical Assistant (1964)
 Norval Reeves, Curatorial Assistant (1971)
 Suzanne Richardson, Curatorial Assistant (1974)
 Orbelia Robinson, Research Assistant (1987–90),
 Editorial Assistant (1991–)
 Lorraine Rogers, Typist (1953–56)
 Barbara Shervanick, Curatorial Assistant (1969–70)
 Robert Setzer, Curatorial Assistant (1969–70)
 Gary Shepard, Curatorial Assistant (1972)
 Quinn Sinnott, Curatorial Assistant (1973–74, 1976)
 Geoff Smick, Curatorial Assistant (2000)
 Gladys Smith, Technical Assistant (1954, 1959–63)
 Linda Smith, Curatorial Assistant (1972–74), Typist
 (1974–75)
 Debbie Stamp, Preparator (1985)
 Mrs. J.M. Stone, Assistant (1948)
 Colleen Sudekum, Curatorial Assistant (1981–90)
 Sanford Tepfer, Assistant (1947)
 Clara Tose, Assistant (1925)
 June A. Tracy, Curatorial Assistant (1974)
 Barbara Trowbridge, Curatorial Assistant (1969–70,
 1978–79)
 Ivan Valdespino, Tilton Postdoctoral Fellow
 (1995–96)
 Elizabeth M. Vincent, Assistant (1943–52)
 Mabel Weed, Assistant (1941)
 Philip Wheeler, Assistant (1965–66)
 Debbie Wilson, Curatorial Assistant (1980–81);
 Preparator (1982–87)
 Randi Wilson, Curatorial Assistant (1978–79)
 Alice B. Wright, Assistant (1941, 1943–47)
 Frank Yamasaki, Curatorial Assistant (1969)

* In a letter of 20 February 1895 from Eastwood to K. Brandegee (preserved in the archives of the University and Jepson herbaria, University of California, Berkeley) Eastwood noted, "Effie is now in the library all the time and I have made out an application for continual assistance in the Herb., which I shall send in at the next meeting of the Council." Hittell (1997:368) noted that on 4 November 1896, "the salary of Miss Effie McIlriach, as assistant secretary and librarian, was raised..." It is unlikely that she was still working in the Department of Botany at that time. She was elected a resident member of the Academy in 1900 (Hittell 1997). Upon her marriage in 1902, she became Mrs. Cloudsley Rutter, was relieved of her duties as assistant secretary and librarian, and appointed to supervise the printing and do the proof-reading of the Academy's publications (Hittell 1997).

** Eastwood's sister, often listed in documents as Mrs. George H. Phelps, appears to have been paid, either for the most part or entirely, by Eastwood for her services to the Department. It is unclear whether she was always paid or whether, in some years (e.g., 1939–40), she worked strictly as a volunteer.

Appendix IV. Apparently unpublished drawings of Kellogg that are extant in the herbarium of the California Academy of Sciences. A drawing of *Mertensia stomatechoides* Kellogg that was published in the protologue of that species (*Proc. Calif. Acad. Nat. Sci.* 2:148. 1863) is also extant at CAS.



FIGURE 30. *Ribes nevadense* Kellogg. "Dr. Kellogg also exhibited a complete drawing of a species of wild Black Mountain Currant, together with specimens of the bush and ripe fruit." (*Proc. Calif. Acad. Nat. Sci.* 1, ed. 2:9. 1873.)



FIGURE 31. *Viola purpurea* Kellogg. "Dr. Kellogg exhibited drawings and specimens of two species of violet from the interior, neither of which are described, so far as we are able to learn." (*Proc. Calif. Acad. Nat. Sci.* 1:56. 1855.)



FIGURE 32. *Fritillaria viridis* Kellogg. "Dr. Kellogg exhibited a drawing, accompanied by specimens of a new species of *Fritillaria*, from New Idria, California, presented by Dr. Veatch, and cultivated by H.G. Bloomer." (*Proc. Calif. Acad. Nat. Sci.* 2:9. 1863.)

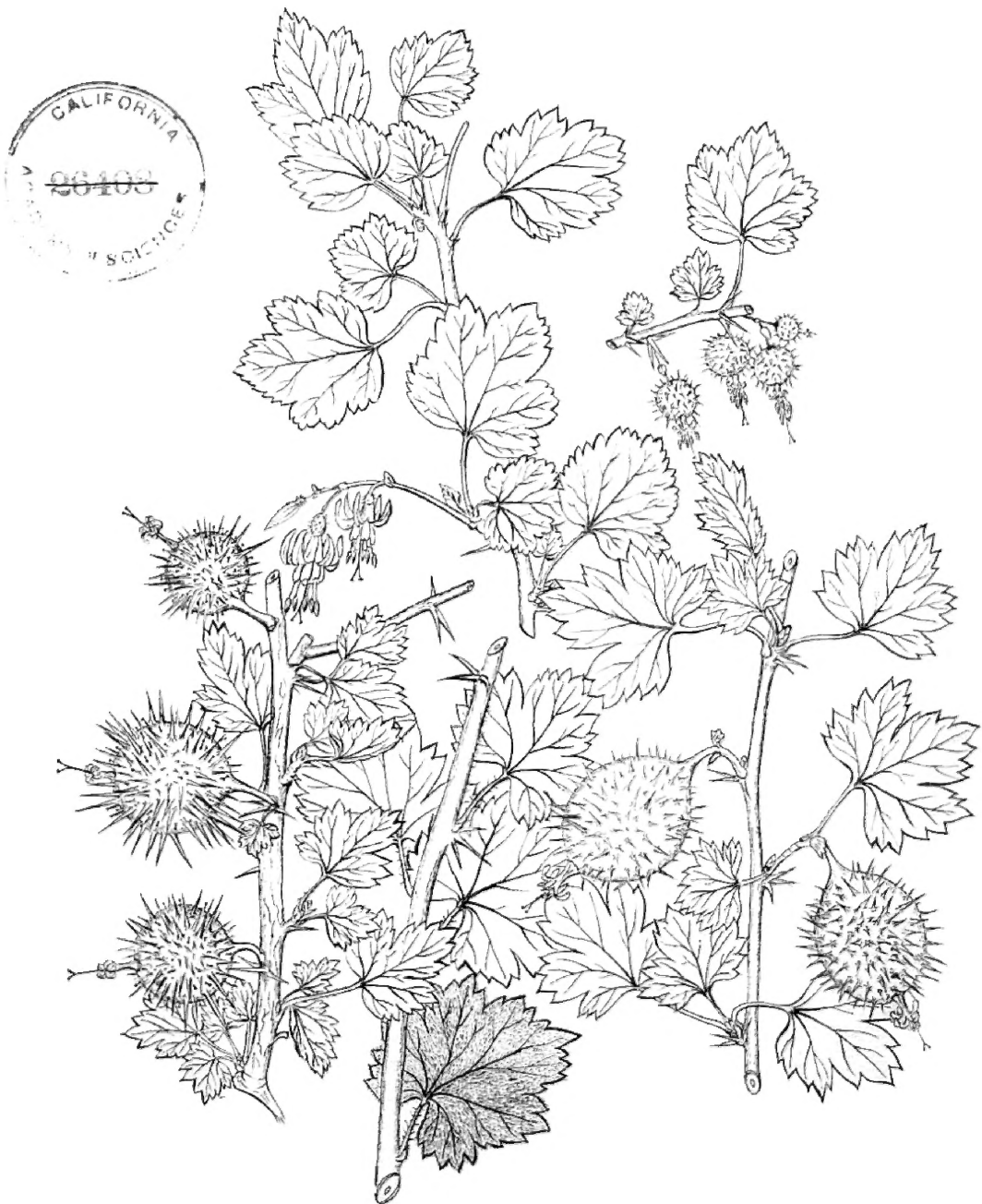


FIGURE 33. *Ribes menziesii* Pursh.

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